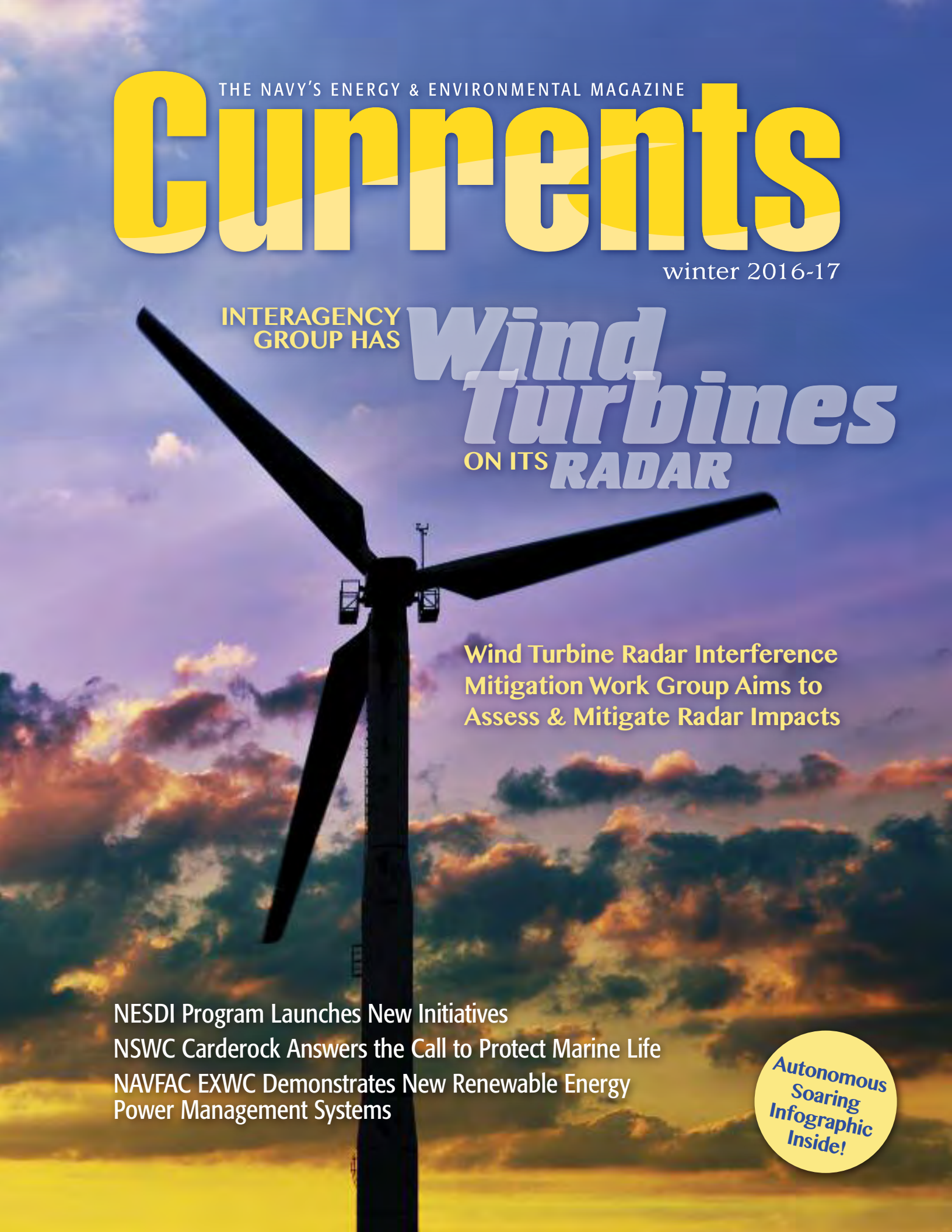

THE NAVY'S ENERGY & ENVIRONMENTAL MAGAZINE

Currents

winter 2016-17

INTERAGENCY GROUP HAS Wind Turbines ON ITS RADAR

Wind Turbine Radar Interference Mitigation Work Group Aims to Assess & Mitigate Radar Impacts

NESDI Program Launches New Initiatives

NSWC Carderock Answers the Call to Protect Marine Life

NAVFAC EXWC Demonstrates New Renewable Energy Power Management Systems

Autonomous Soaring Infographic Inside!

THE NAVY'S ENERGY & ENVIRONMENTAL MAGAZINE

Currents

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cover

The interagency Wind Turbine Radar Interference Mitigation work group is addressing potential wind turbine interference with federal (including Navy) radar systems by identifying effective mitigations to this complex issue through research and development, coordination and outreach.

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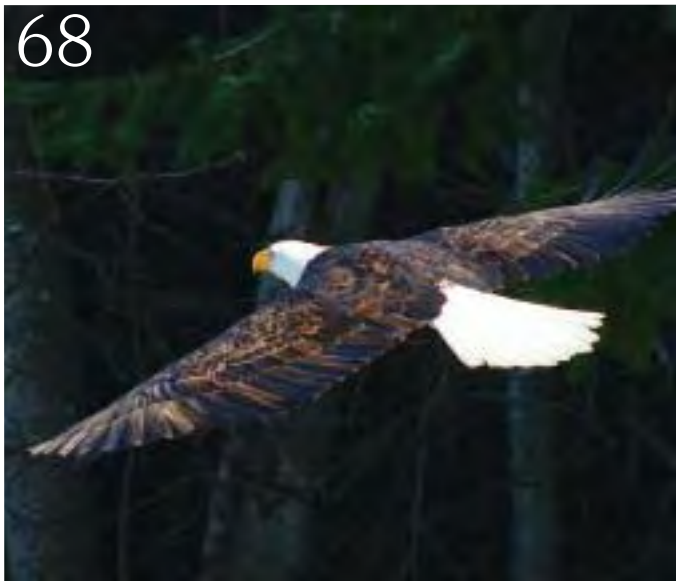
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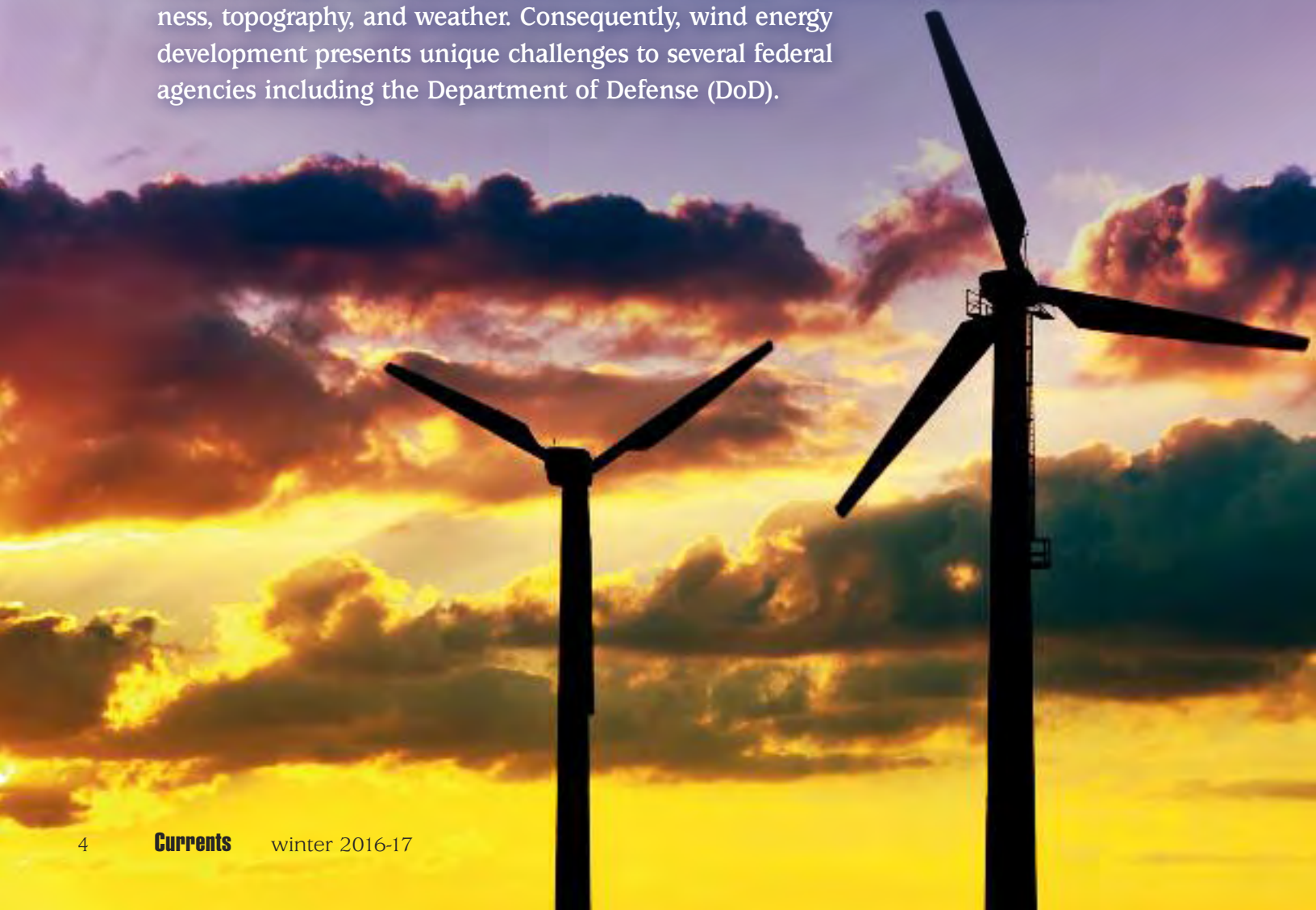
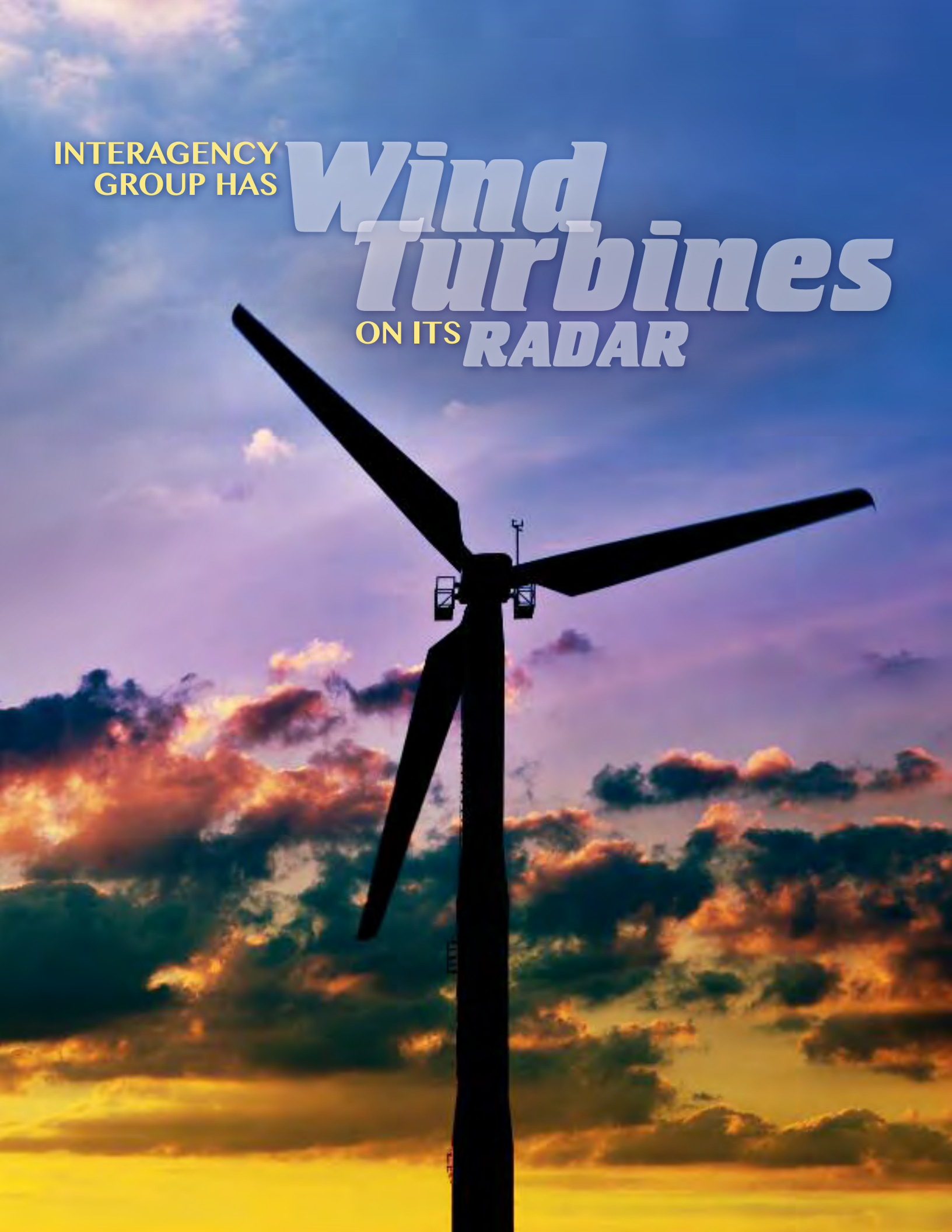
Wind Turbine Radar Interference Mitigation Work Group Aims to Assess & Mitigate Radar Impacts

The interagency Wind Turbine Radar Interference Mitigation (WTRIM) work group is addressing potential wind turbine interference with federal (including Navy) radar systems by identifying effective mitigations to this complex issue through research and development, coordination, and outreach.

Over the past few years, the country's energy portfolio has rapidly diversified with renewable energy generation, including solar, wind, and geothermal becoming increasingly mainstream. According to the U.S. Department of Energy, renewable energy accounted for approximately 13.5 percent of energy generation in the United States in 2014. But as renewable energy generation increases, in particular from wind, land and airspace use, challenges are becoming more apparent.

The best locations for wind turbines often coincide with areas that are optimal for radar and flight operations conducted by the military—reasons being their remoteness, topography, and weather. Consequently, wind energy development presents unique challenges to several federal agencies including the Department of Defense (DoD).




INTERAGENCY GROUP HAS
Wind Turbines
ON ITS RADAR

The best locations for wind turbines often coincide with areas that are optimal for radar & flight operations conducted by the military.

Wind turbines located near or adjacent to radars or under certain types of air space can cause adverse impacts. [illegible] potentially affect the quality of communication systems and [illegible] radars. Electromagnetic interference with radar is the [illegible]

Naval Station Guantanamo Bay, Cuba. Often locations that are optimal for wind energy development share characteristics that make them ideal for military radar operations, such as topography and weather.
Chief Mass Communication Specialist Bill Mesta

About Radar

Radar works much like echolocation in bats. The transmitter emits pulses of microwaves, which are broadcast by an antenna. When these waves encounter an object, the radar system calculates the size and distance of the object.

The most prevalent form of radar in use today is Doppler radar. The "Doppler Effect" tracks the microwave signal reflected off a moving object and analyzes how its motion has altered the frequency or phase of the returned signal over time. This determines the object's velocity. (This is [illegible] Doppler radar also uses speeding.)

Radar interference from wind turbines can create the appearance of false targets—making it harder to identify hostile aircraft and potentially endanger air crews.
MC3 Kasey Krall

1. The Federal Aviation Administration (FAA) for air traffic control.
2. The National Oceanic and Atmospheric Administration (NOAA) to track weather patterns.
3. The Department of Homeland Security (DHS) for border and [illegible]
4. The DoD to track hostile, unidentified, and friendly targets in the air, [illegible]

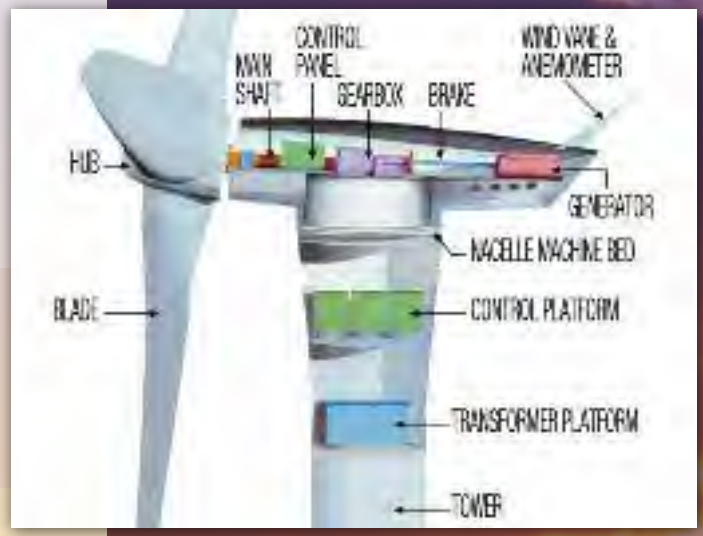
Interference with Doppler Radar

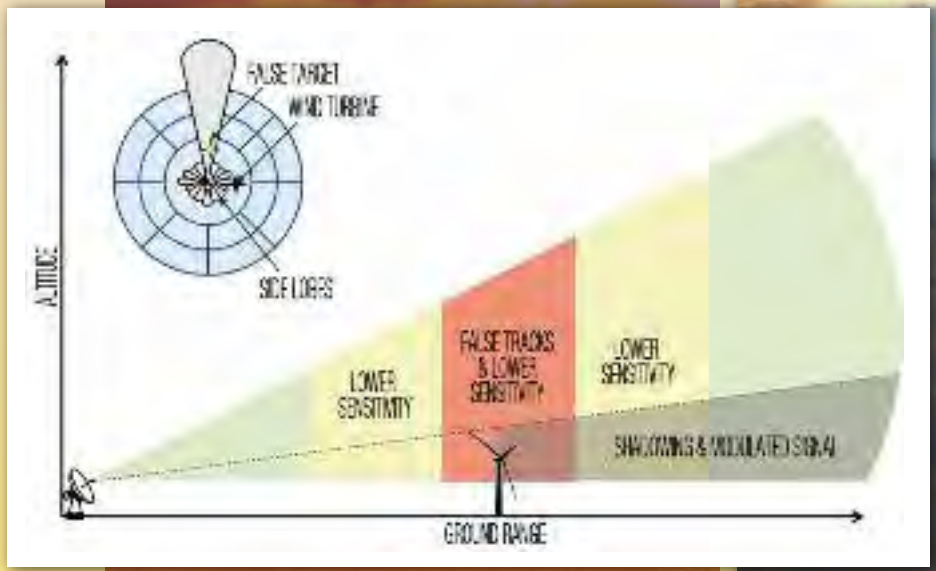
A wind turbine hub rotates 360 degrees. A typical turbine with 200-foot-long blades moves around the hub very quickly. At an optimal wind speed for generating energy, the hub will rotate at roughly 14 revolutions per minute, which translates to the

The Problems with *Turbines*

The problems with wind turbines is that they can:

1. Cause physical obstruction and pose safety hazards to aircraft during take-off or landing.
2. Affect the quality of communication systems and impact air navigation systems.
3. Interfere with military, weather, and air traffic control radars.





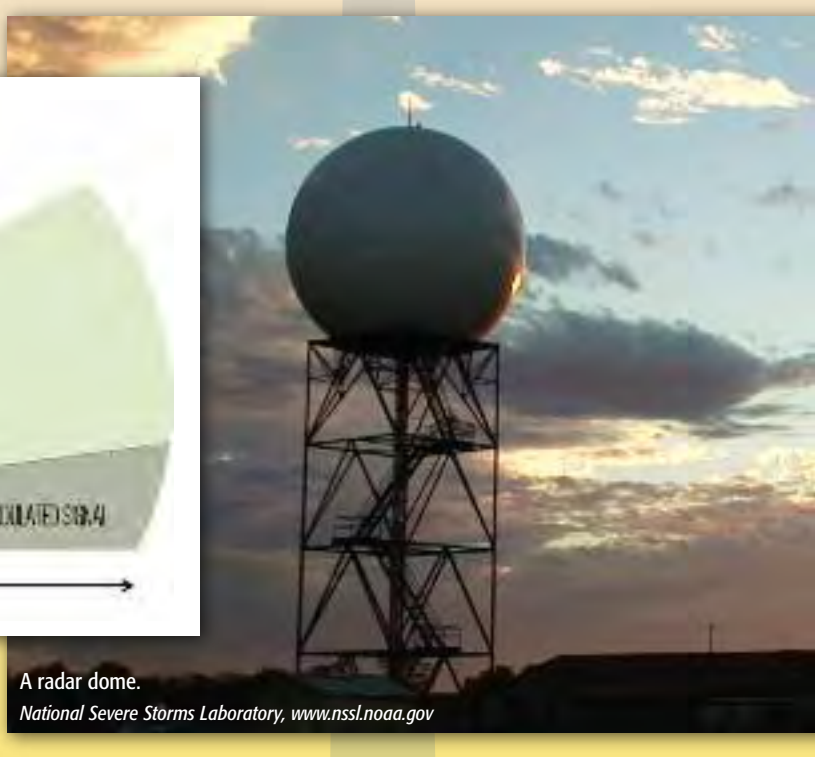
tip of the blade rotating up to 225 miles per hour—the speed of a small aircraft. Depending on the angle of the turbine to the radar receiver, each blade tip has the potential of being detected. The angle of the turbine determines the type of false target on the radar screen, such as a target traveling towards the radar, going away from the radar, or crossing the radar screen.

Complicating the issue is the fact that turbines are generally grouped together, which can lead to cumulative effects. As a result, the impact from a group of turbines, each with three rotating blades, can quickly burden a radar system with thousands of false targets.

A real target, such as an enemy aircraft, can be easily lost in what appears as a blizzard of false targets. This is of particular concern for DoD when conducting radar-dependent test and training activities or missions.

An Interagency Solution to an Interagency Problem

In 2012, four federal agencies, the Department of Energy (DOE), DoD, DHS, and the FAA, pooled resources to conduct three complex field tests that measured the impact of wind turbines on Doppler air surveillance radars and to test the ability of private sector technologies to mitigate such interference.



A radar dome.
National Severe Storms Laboratory, www.nssl.noaa.gov

The results of the IFT&E program indicated the impact of wind turbine interference on the three radar types was significant.

Rotating wind turbine blades can cause several adverse impacts to military operations, including physical obstruction to aircraft, electromagnetic interference, and interference with radars.
Airman 1st Class Amber Carter

Wind turbines at U.S. Naval Station Guantanamo Bay are 80 meters (262 feet) high and provide energy for the naval station and Joint Task Force Guantanamo.
Kathleen T. Rhem

The two-year effort was known as the Interagency Field Test & Evaluation (IFT&E) program. Each field test was conducted close to an existing Doppler radar where a large number of wind turbines were in view. In total, the study assessed three impacted radars and eight potential industry mitigation solutions.

The results of the IFT&E program indicated the impact of wind turbine interference on the three radar types was significant. In areas where wind turbines were not present, all radars demonstrated the ability to meet or exceed their detection requirements. However, target detection in regions over and near wind turbines suffered a notable drop in maintaining a real target, and an associated rise in false detection reports.

While several mitigation technologies tested showed promise, they were not fully mature, and required additional development and testing, including the need to address deployment and integration. The IFT&E program demonstrated that federal agencies, with seemingly disparate missions, could successfully collaborate. To continue the IFT&E's momentum, the WTRIM work group was established in 2014.

Member agencies include the IFT&E participants: DoD, DOE, NOAA, and FAA. DHS and the Department of Interior (DOI) also participate as observers.

WTRIM-funded Research & Development Efforts

Co-funding an enhanced version of the U.S. Geological Survey (USGS) wind turbine database, USGS developed a publicly available data set to track wind turbine locations. WTRIM member agencies and industry stakeholders would benefit from having access to enhanced and up-to-date data from a common wind turbine database. The existing USGS data set is available at www2.usgs.gov/blogs/features/usgs_top_story/mapping-the-nations-wind-turbines.

Pilot Mitigation Project at Travis Air Force Base

This project was formed to provide a mechanism for government to partner with industry to facilitate both wind energy development and the long-term on-site testing of mitigation solutions, including a class of new radar systems with advanced clutter detection capabilities known as "in-fill" radar. A number of these systems were tested under the IFT&E program; this project would set standards for employing these systems in the future.

Radar Obstruction Evaluation Model/Simulator (ROEMS) Upgrade

ROEMS is a 3D radar modeling tool originally developed for NORAD to support radar performance evaluations and operational mission impact analysis. The WTRIM work group has supported upgrading the tool and making it more available to federal agencies that have a modeling and simulation program. Analytical Graphics, Inc. completed and recently delivered the upgraded tool, now called ROEMS II, to NORAD.

Ground-Based Coastal Air Surveillance Radar Wind Turbine Radar Interference Vulnerability Study

MIT LL will assess geographic areas and associated coastal air surveillance radars that may be impacted by offshore wind turbines. The study will characterize coastal radar clutter environments before and after the installation of offshore wind turbines. Using the data collected, the study will assess how well current mitigation technologies will perform compared to land-based wind turbine settings and will recommend new mitigation technologies specifically tailored for offshore issues. Additionally, the study will identify shortfalls and recommend improvements to current wind turbine radar interference modeling and simulation tools such as ROEMS II.

Since these agencies rely on Doppler radar, they are susceptible to degraded radar performance due to wind turbine interference. Additionally, these agencies' radars are frequently inter-linked to maximize their coverage zone (ranging from a region to a continent).

Other Participants

In addition, a diverse number of other stakeholder organizations participate in the WTRIM work group, including representatives from the military (e.g., Coast Guard and North American Aerospace Defense Command (NORAD)); federal agencies (e.g., Bureau of Ocean Energy Management; the DOD/DHS inter-Department Long Range Radar Joint Program Office). Further, several national laboratories such as Sandia National Laboratories and the Massachusetts Institute of Technology Lincoln Laboratory (MIT LL) are important contributors to helping the WTRIM work group identify, design, and test various approaches to mitigating wind turbine induced interference.

The WTRIM work group focuses on mitigating the technical and operational impacts of wind turbine projects on various federal radar missions. To achieve this objective the group set two goals. First was to pursue and develop technical mitigation solutions by identifying the "low-hanging fruit" that could serve as an interim fix until more advanced technical solutions could be developed, tested, and deployed.

A radar dome.

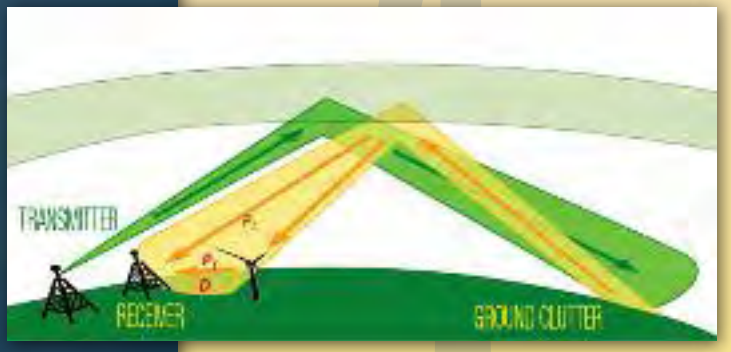
The WTRIM work group focuses on mitigating the technical & operational impacts of wind turbine projects on various federal radar missions.

The wind turbines on top of John Paul Jones Hill have been fully operational at Naval Station Guantanamo Bay, Cuba since July 2005.
Spc. Megan Burnham

These solutions, while primarily technology-driven, can also include policy and legislative approaches. The second goal is for the WTRIM member agencies to determine funding requirements and levels of contribution to develop and make solutions available.

To that end, WTRIM work group member agencies collectively fund research and development projects to identify issues and solutions to assess, manage, or prevent interference. In 2015, DoD, DOE, and FAA agreed to a robust integrated research and development budget plan to develop and field effective radar mitigation solutions. For fiscal years 2016 and 2017, this amount totals $3.9 million. The intent of the plan is to address the following strategic themes:

1. Improve the capacity of government and industry to evaluate the impacts of wind energy installations on sensitive radar systems.
2. Develop and facilitate the deployment of mitigation measures to increase the resilience of existing radar systems to wind turbines.
3. Encourage the development of next-generation radar systems that are resistant to wind turbine radar interference.



The ROTHR works by bouncing signals off the ionosphere. The system is comprised of a transmitter and receiver. The WTRIM work group is involved in a study to verify the efficacy of an MIT LL-developed model to predict effects of wind turbines on this unique radar system.
MIT/Lincoln Laboratories

A Closer Look at Impacts to Navy Radar

For the past three years, the WTRIM work group has been involved with a study assessing the efficacy of an existing MIT LL model to protect the Navy-owned and operated Relocatable Over-the-Horizon Radar (ROTHR). The ROTHR provides wide-area air and sea surveillance to military and law enforcement agencies. More specifically, ROTHR supports the U.S. Southern Command's drug interdiction mission. There are three ROTHR systems in the U.S.—two are located in Texas, one in North Carolina, and another in Puerto Rico. Due to the abundance of wind resources near these sites, all are increasingly threatened by wind turbine projects. The radar's unique use of the ionosphere to obtain extremely long-range tracking of suspect targets makes it highly vulnerable to electromagnetic interference emanating from wind turbines.

The MIT LL-developed model predicted the impact of the new wind turbine projects would not exceed acceptable limits of interference on the ROTHR systems if wind developers agree to certain limitations, such as altering a project's site layout and reducing the number of turbines. Based on the MIT LL model, DoD reached several agreements with wind developers whose proposed projects could potentially impact the ROTHR systems. Following the installation of each turbine, the developer will conduct tests for each turbine and associated equipment to gauge impacts on the ROTHR. Mechanisms to address radar impacts, should they occur in the future, include provisions to temporarily lock wind turbine blades from rotating. This current study, largely funded by the DoD Siting Clearinghouse (SCH), is essentially evaluating the accuracy of the MIT LL model.

As the nation's energy portfolio continues to shift toward renewable sources, proactive efforts like the WTRIM work group will be critical, not only in preserving vital military and other federal agency mission capabilities, but also in safeguarding the country's investment in radar systems.

To learn more about the WTRIM work group, visit http://energy.gov/sites/prod/files/2016/06/f32/Federal-Interagency-Wind-Turbine-Radar-Interference-Mitigation-Strategy-02092016rev.pdf.

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DoD on the WTRIM

The DoD SCH is the DoD representative on the WTRIM work group. The DoD SCH was formally established in 2011 to coordinate the review and assessment of impacts of wind, solar, transmission line, and other projects to military activities. As in the case of the Navy ROTHR, the DoD SCH is able to identify feasible and affordable long-term actions, including funding research and development and signing mitigation agreements with developers to address adverse mission impacts resulting from wind turbines.

Wind energy will continue to play an important role in our nation's energy portfolio.
—Ron Tickle

"Wind energy will continue to play an important role in our nation's energy portfolio; therefore, it is critical DoD remain engaged with other Federal agencies and the private sector to further understand issues and identify solutions," explained Ron Tickle, Director of the DoD SCH. "The interagency nature of the WTRIM work group provides DoD with a holistic view when assessing and mitigating potential impacts. Understanding the different agencies' missions and goals leads to more collaborative solutions to the complex, and often project-specific issues resulting from wind turbine interference."

To learn more about the DoD Siting Clearinghouse, visit www.acq.osd.mil/dodsc.

Point Mugu Restores Critical Wetlands

Native Saltmarsh Plants & Tidal Channels Enhance Habitat, Support Mission

BASE PERSONNEL FROM the environmental department onboard Naval Base Ventura County (NBVC) Point Mugu, California with some help from the Channel Islands Restoration (CIR) staff and volunteers are enhancing critical wetlands without competing with the base's military mission.

NBVC Point Mugu with restoration site outlined (west of Las Posas between 12th and 13th Streets).
Google Earth

Coastal saltmarsh wetlands are a rare habitat in California and the Mugu Lagoon estuary complex located on NBVC Point Mugu is the largest in Southern California. There are over 2,100 acres of wetlands which supports hundreds of species, including 230 bird and 204 native plant species. Seven of these species are rare, threatened or endangered, and protected by environmental laws. NBVC Point Mugu has a comprehensive wetland restoration program that effectively protects this valuable resource while maintaining efficiency in implementing the base's military mission.

After removing an invasive iceplant and lowering the elevation to increase tidal inundation, native saltmarsh species are planted.
Emily Chase

Some projects or operations on NBVC Point Mugu occasionally require mitigation for impacts to wetlands. These impacts rarely occur even though the wetland complex on base is 48 percent of the total land area for the installation. Wetland restoration projects, implemented on the base since the 1990's, are executed by personnel from the NBVC Point Mugu Environmental Division which oversees the associated construction, restoration, and permitting activities. The proactive wetland restoration projects provide opportunities for instant mitigation acreage if damage to wetlands occurs.

Currently, there is an effort to restore salt marsh in an abandoned land fill. The salt marsh vegetation used in restoration projects at Point Mugu require variable water inputs, particular elevation levels, and have different salt tolerance; these conditions can make it difficult to predict the success of restoration projects. "The features that make natural

CIR staff and volunteers installed 5,000 native plants. Flags mark the area where various species are planted.
Joshua More

The CIR nursery grows plants with seeds collected near restoration site so plants are adapted to the local environment.
Kelle Green

coastal wetlands unique are the same features that create restoration challenges: Their physiochemical environment is complex; they are biologically diverse, and they are vulnerable to changing sea levels. The complex physiography of coastal wetlands is difficult to create or restore, especially where prior landforms have been obliterated through filling." (Source: Handbook for Restoring Tidal Wetlands, Zeller, 2001.) This is the case at the 12th Street restoration site since it was historically used as a land fill disposal site. The contents were removed and clean sediment was added before native plants (Western marsh rosemary) were reestablished.

Five thousand native plants were installed by Channel Islands Restoration (CIR) staff and volunteers. The native plants were started from seeds and cuttings collected at NBVC Point Mugu and grown in CIR's nursery. Biochar was added in some areas of planting as an experiment to see if it increases the growth of the plantings. Biochar is made from organic matter heated until it decomposes; the result is a high carbon product with high surface area good for retaining water and nutrients in soil. It has been used at NBVC Point Mugu before with positive results of native vegetation colonizing the mounds and trenches where it had been placed. This has positive implications especially for newly restored areas that may not have developed the rich, biogenic soils required for salt marsh plant recruitment. (Source: www.biocharsupreme.com/pages/understanding-biochar.)

Some restoration projects, such as the one on 12th Street, may be entered into the NBVC wetland mitigation program—a program that is currently being developed in partnership with the U.S. Army Corps of Engineers. The purpose of the NBVC wetland mitigation program is to create in advance of the need, economically efficient and flexible wetland mitigation opportunities. The principle goal of the program is to sustain no net loss of wetlands and a no net loss of military mission or readiness.

The Basics About CIR Projects

CIR PROJECTS PROTECT rare and endangered plants and animals by restoring habitat in sensitive and unique natural areas on the California Channel Islands and adjacent mainland. The CIR educates a variety of groups about the value of native habitat and how to protect it and recruits volunteers and develops public and private funding sources for habitat restoration programs. For more information about or to volunteer with CIR, visit http://cirweb.org/volunteer2.htm.

TOP LEFT: Western marsh rosemary (*Limonium californicum*).

TOP RIGHT: Woolly seablight (*Suauda taxifolia*).

ABOVE: Fleshy jaumea or marsh jaumea (*Jaumea carnosa*) has a yellow daisy-like flower and blooms from April until December.

Emily Chase

Base operations that may impact wetland habitat are permitted and monitored to minimize changes to hydrology and habitat function because they are protected by federal and state laws. Mitigation for wetlands can be a long process to develop the habitat type that was impacted. The 12th Street restoration site is a prime example of how land can be returned to its natural state before mitigation is required. Key elements and benefits of this program include:

- Restoration sites are pre-approved by installation authorities through a vetting process that selects for appropriate sites (sites that can be connected to the existing hydrology and naturally maintained) and eliminates any site that has a potential for future base facilities.
- A detailed mapping process included in the program depicts all potential sites and projected levels of effort required to restore the site.
- Proactive restoration creates sites well in advance of the need, which not only creates an ecologically high-value site, but also affords a temporal value for wetland function.
- Some sites are selected to allow for storm surge or incremental sea level rise which supports climate change requirements in the base's Integrated Natural Resource Management Plans. These "pre-storation" sites will accommodate salt marsh migration in an area that has limited available area due to topography, highways, and agricultural areas that occur outside of base boundaries.

After successful restoration and monitoring, the 12th Street restoration site can be assessed as a fully functioning wetland. The varying topography and vegetation provide good tidal connection, critical environmental conditions to maintain healthy populations of benthic invertebrates, and ample support to the higher trophic level species that depend or utilize this salt marsh habitat. The proximity of this site to the wetlands north and south increases the overall area that supports wildlife either for resting and/or foraging. These programs that support the complex interactions between water, land, plants, animals and the military mission can be challenging. It takes thoughtful, long-term planning and military support to achieve great rewards. ⚓

Valerie Vartanian
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ONE OF MY Best Shots

I captured this photo of a brown lizard on coconut husks in my garden near Pearl Harbor, Hawaii, using a Samsung Galaxy S6 Edge. Likely a brown anole (*Anolis sagrei*), it is one of the many non-native lizards that have found their way to Hawaii.

John Burns ◉ Administrative Support Assistant ◉ Navy Region Hawaii ◉ john.burns2@navy.mil

Editor's note: We think this photo helps to demonstrate that great shots come from a good eye and don't require special equipment. We encourage our readers to keep their eyes open and cameras of all types at the ready.

Submit your own Best Shot to Bruce McCaffrey ◉ *Currents*' Managing Editor ◉ brucemccaffrey@sbcglobal.net

Power Savings: ONR Research Helps Navy Curb Kilowatts

Portable System Monitors Electricity Used by Individual Appliances & Other Devices

WITH SUPPORT FROM the Office of Naval Research (ONR), engineers at the Massachusetts Institute of Technology (MIT) have designed a portable measurement system to precisely and cheaply monitor the amount of electricity used by individual household appliances, lighting fixtures and electronic devices.

"Supporting research that targets key military and national energy challenges is a vital component of ONR's mission, which is to drive technology advancements," said Dr. Richard Carlin, head of ONR's Sea Warfare and Weapons Department. "Projects like this have the potential to address broad energy needs."

The system was developed by Dr. Steven Leeb, an MIT engineering professor, and Dr. John Donnal, one of Leeb's graduate students and a former U.S. Army captain. It comprises five postage stamp-sized sensors placed above or near power lines coming into a house. The sensors are designed to be self-calibrating—enabling them to automatically pinpoint the strongest electrical signals.

The system can distinguish between each type of light, appliance and device based on unique signatures; which ones turn on and off; and how often and at what times. It then displays this data in real time on an app that allows users to focus on specific time segments—revealing when, for example, a refrigerator goes into its defrost cycle, or how regularly a water heater switches on and off each day.

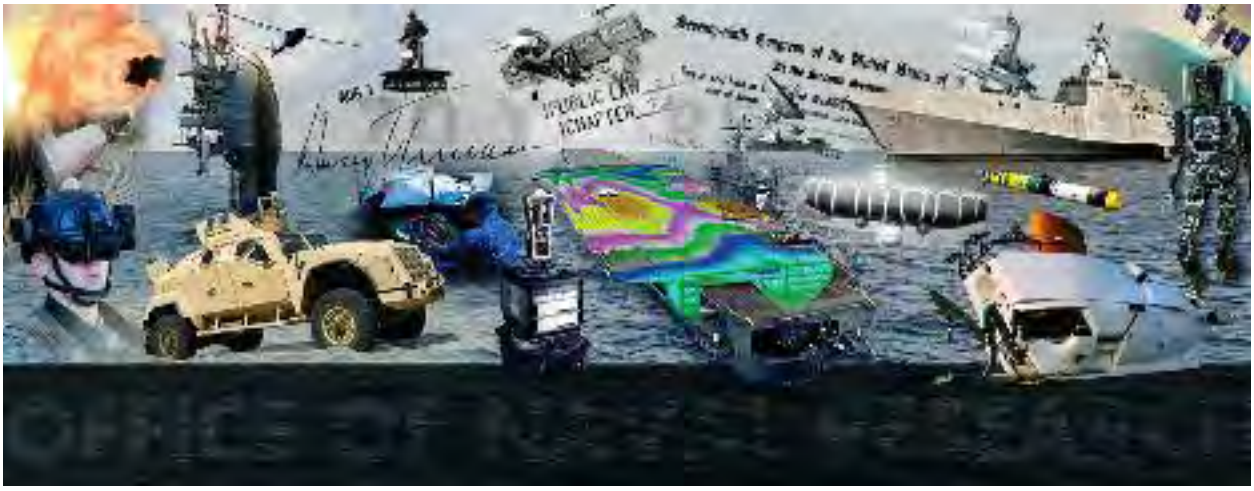
"There are already ways to monitor household energy use," said Leeb, "but they involve hiring a licensed electrician or cutting through power lines or pipes to attach expensive, specialized equipment. With our system, you can install non-contact sensors using zip ties or even velcro, and use signal processing to measure power consumption. It's fast, easy and much less expensive. It also could serve as a way to tell when equipment needs maintenance or replacement."

While the benefits to civilians are obvious, the system could be a valuable tool for the military. Consider a forward operating base in a combat zone, for example. Using MIT's technology not only could generate major savings in fuel or power—it also may safeguard the lives of warfighters responsible for base resupply.

"The military is an ideal customer for this technology," said Donnal. "At a forward operating base, fuel conservation is paramount. Heating and air-conditioning thermostats run too high or too low. Large tents are heated all day during winter, even if they're unoccupied during daytime hours."

With our system, you can install non-contact sensors using zip ties or even velcro, and use signal processing to measure power consumption.

–Dr. Steven Leeb



Using MIT's technology not only could generate major savings in fuel or power—it also may safeguard the lives of warfighters responsible for base resupply.

"Or take the case of a Navy vessel," he continued. "By cutting back on fuel and power consumption, a vessel might be able to sail for longer periods of time before needing replenishment. Having a way to track energy usage in real time would be extremely valuable."

Leeb is conducting at-sea tests of the system aboard three U.S. Coast Guard cutters based in the Boston area, to mirror some of the conditions and challenges facing Navy vessels. Donnal, an assistant professor at the U.S. Naval Academy, plans additional tests on the training ships the school uses to teach midshipmen navigation and seamanship.

Leeb's research is part of the Naval Enterprise Partnership Teaming with Universities for National Excellence (NEPTUNE) initiative conducted by ONR and the Department of the Navy.

NEPTUNE's goals are to help the Navy and Marine Corps discover ways to improve energy conservation, generate renewable energy and implement energy-efficient technologies—while giving active-duty military, military students and veterans the chance to immerse themselves in university-level research.

For more insights into this and other ONR-sponsored technologies, visit www.onr.navy.mil. ⚓

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Office of Naval Research Turns Seventy

ONR CELEBRATES 70 years of innovation in 2016. For seven decades, ONR through its commands–including ONR Global and the Naval Research Laboratory in Washington, D.C.–has been leading the discovery, development and delivery of technology innovations for the Navy and Marine Corps.

Uniform National Discharge Standards Coming Soon

Navy & EPA Develop Environmental Requirements for Discharges from Armed Forces Vessels

THE NAVY AND the U.S. Environmental Protection Agency (EPA) recently published proposed discharge performance standards for 11 discharges incidental to the normal operation of a vessel of the Armed Forces. These proposed discharge standards are in addition to the 11 discharge performance standards previously proposed by the Navy and the EPA. These requirements are intended to enhance the operational flexibility of these ships both domestically and internationally, stimulate the development of innovative shipboard pollution control technology, and advance the development of environmentally sound ships.

The Navy is a good steward of the ocean, but in the 1990's realized that it was becoming more difficult to be aware of, and compliant with, the variety of environmental requirements in each state and homeport where ships traveled. To provide consistent operating instructions that all ships could understand and implement, the Navy sought uniformity in the requirements to control discharges incidental to the normal operation of a vessel of the Armed Forces.

Ships Need Uniform Discharge Requirements

The Federal Water Pollution Control Act of 1972, commonly referred to as the Clean Water Act, authorizes the EPA to regulate discharges of pollutants into U.S. waters. As a result, some individual states are free to impose regulations that would apply only in waters subject to the state's authority. (Normally, states have authority to regulate out to three nautical miles from the state's coastline.) Without comprehensive federal regulation, the Navy worried that if each U.S. coastal state chose to impose unique and separate requirements, each ship's commanding officer would need to manage and employ widely disparate protective measures to obey state law depending on the ship's location. The Navy also feared that its acquisition officials would be required to procure shipboard equipment for a constantly shifting and unpredictable landscape of environmental requirements. Required equipment that might be easily installed on a commercial ship could be difficult or impossible to place and operate on a Navy ship with the severe space, weight, and operational constraints they have in comparison to their civilian counterparts.

Request for Uniform Discharge Standards

Against this regulatory backdrop, in the early 1990s, the Navy asked the Department of Defense (DoD) and Congress to create a Uniform National

To provide consistent operating instructions that all ships can understand and implement, the Navy sought uniformity in the requirements to control discharges incidental to the normal operation of a vessel of the Armed Forces.

Constant review of standards ensures that the Navy will incorporate new pollution control technologies into the UNDS program when proven effective for use onboard Armed Forces ships.

Discharge Standards (UNDS) program for liquid discharges under the Clean Water Act. Congress responded via the 1996 National Defense Authorization Act, which amended the Clean Water Act to establish the UNDS program for vessels of the Armed Forces in Section 312(n). This established a three-phase process for implementing discharge regulations applicable to vessels operated by any branch of the Armed Forces, defined for the purpose of UNDS to include U.S. Coast Guard ships.

Phase I requires DoD and the EPA to jointly determine all discharges incidental to the normal operation of a vessel of the Armed Forces, and also to determine which discharges require control by a Marine Pollution Control Device (MPCD)—any equipment or management practice installed or used onboard a vessel to control a discharge—before the discharge may be introduced into the marine environment. This is based on the following seven factors:

1. Nature of the discharge
2. Environmental effects of the discharge
3. Practicability of using a MPCD
4. Operational impact of using a MPCD on a vessel
5. Applicable U.S. law
6. Applicable international standards
7. Costs of MPCD installation and use

For Phase I of UNDS, the DoD delegated its responsibility to work with the EPA to the Navy, and in May 1999 Phase I was completed. In all, 39 discharges incidental to the normal operation of a vessel of the Armed Forces were identified, 25 of which were determined to require control.

Discharges Requiring Control

There are 25 discharges incidental to the normal operation of a vessel of the Armed Forces that were determined to require control. The requirements for these discharges are being developed in three batches. Batch One has 11 discharges, Batch Two has 11 discharges, and Batch Three has three discharges.

Batch One (11)

1. Aqueous Film-Forming Foam
2. Chain Locker Effluent
3. Distillation and Reverse Osmosis Brine
4. Elevator Pit Effluent
5. Gas Turbine Water Wash
6. Non-Oily Machinery Wastewater
7. Photographic Laboratory Drains
8. Seawater Cooling Overboard Discharge
9. Seawater Piping Biofouling Prevention
10. Small Boat Engine Wet Exhaust
11. Welldeck Discharge

Batch Two (11)

12. Catapult Water Brake Tank and Post-Launch Retraction Exhaust
13. Controllable Pitch Propeller Hydraulic Fluid
14. Deck Runoff
15. Firemain Systems

The Navy and the EPA modeled and analyzed a number of different homeports in the country to provide for appropriate representation, distribution, and operation of the vessels of the Armed Forces.

16. Graywater
17. Hull Coating Leachate
18. Motor Gasoline Compensating Discharge
19. Sonar Dome Discharge
20. Submarine Bilgewater
21. Surface Vessel Bilgewater/Oil-Water Separator Discharge
22. Underwater Ship Husbandry

Batch Three (3)

23. Clean Ballast
24. Compensated Fuel Ballast
25. Dirty Ballast

Discharges Not Requiring Control (14)

The following 14 discharges were determined to not require control under the UNDS program.

1. Boiler Blowdown
2. Catapult Wet Accumulator Discharge
3. Cathodic Protection
4. Freshwater Lay-Up
5. Mine Countermeasures Equipment Lubrication
6. Portable Damage Control Drain Pump Discharge
7. Portable Damage Control Drain Pump Wet Exhaust
8. Refrigeration and Air Conditioning Condensate
9. Rudder Bearing Lubrication
10. Steam Condensate
11. Stern Tube Seals and Underwater Bearing Lubrication
12. Submarine Acoustic Countermeasures Launcher Discharge
13. Submarine Emergency Diesel Engine Wet Exhaust
14. Submarine Outboard Equipment Grease and External Hydraulics

After completion of UNDS Phase I rulemaking, the Clean Water Act preempted states from adopting or enforcing controls for discharges determined to not require control

(14 UNDS discharges) as they apply to vessels of the Armed Forces. A state may petition the EPA and DoD to review a determination of whether a MPCD is required to control a discharge from a vessel of the Armed Forces where there is new, significant information not considered

previously by the EPA or DoD.

Phase II requires DoD and the EPA to jointly determine MPCD performance standards for those discharges

requiring control. A MPCD can be either equipment or a

management practice.

Phase III requires DoD to issue regulations specifying requirements for the design, construction, installation, and use of MPCDs for vessels of the Armed Forces. Upon completion of Phase III, existing state or local regulations for the discharges will be nullified and future state or local regulatory action will be preempted. However, states can petition EPA to establish a no-discharge zone for specific discharges.

Impacts of Batch One Ship Discharges

In 2014, EPA and the Navy reached final agreement on the 11 Batch One standards. A Notice of Proposed Rulemaking for the 11 Batch One standards was published in the Federal Register on February 3, 2014 with a 60-day public comment period. One comment was received.

Before finalizing the Batch One standards, DoD and the EPA are required to conduct an Endangered Species Act (ESA) Consultation with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service (collectively "the Services"). Federal agencies must ensure the actions they take, including those they fund or authorize, do not jeopardize the existence of any listed species. Navy and the EPA developed an ESA Biological Evaluation (BE) for the Batch

One standards to support this ESA consultation requirement. The Navy and the EPA modeled and analyzed a number of different homeports in the country to provide for appropriate representation, distribution, and operation of the vessels of the Armed Forces. In addition, the Navy and the EPA identified listed aquatic and aquatic-dependent species and their critical habitats that could be negatively impacted by the Batch One standards. The BE developed by the Navy and the EPA determined that the Batch One standards will either not affect or are not likely to adversely affect endangered species. The BE was submitted to the Services for their review in October 2016.

Another step that must be completed before finalizing the UNDS Batch One standards is to determine if the discharge standards are consistent with the requirements of the Coastal Management Plans (CMP) of U.S. states and territories, as required by the Coastal Zone Management Act. The Navy and the EPA reviewed the CMPs of 34 states and territories. The resulting National Consistency Determination was provided to the states and territories in August 2016, and stated that the requirements for the UNDS Batch One discharges are consistent with all of the U.S. CMPs. The states and territories are currently reviewing the National Consistency Determination.

In anticipation that the requirements of the UNDS Batch One standards will be finalized in early 2017, Navy stakeholders have met in a series of work group meetings to draft an UNDS Implementation Plan to ensure that Navy ships can be compliant with these requirements. This plan considers roles and responsibilities, training, recordkeeping, reporting, and documentation.

UNDS are intended to enhance the operational flexibility of Navy ships, stimulate the development of innovative shipboard pollution control technology, and advance the development of environmentally sound ships.

Proposed Requirements for Batch Two Discharges from Ships

Meanwhile, the Navy and the EPA have developed standards for 11 more discharges, known as Batch Two. A Notice of Proposed Rulemaking for the 11 Batch Two standards was published in the Federal Register on October 7, 2016 with a 60-day public comment period.

In 2017, Navy and the EPA will evaluate the impacts of the 11 Batch Two standards by developing a BE as required by ESA, and a National Consistency Determination as required by CZMA. The Navy has begun work with DoD to develop implementing regulations for MPCDs for the Batch One and Batch Two standards.

Requirements for the Remaining Three Discharges from Ships

The final three discharges from vessels of the Armed Forces that were determined to require control in Phase I are known as Batch Three and include clean ballast, compensated fuel ballast, and dirty ballast. The Navy and the EPA will begin developing the Batch Three standards in late 2017.

Even after Phase III was completed for all MPCDs covering the 25 UNDS discharges requiring control, efforts to ensure the best, most effective measures to minimize the environmental impact of UNDS discharges waters will not end. The Navy will continue its record of environmental stewardship. In addition, the Clean Water Act requires DoD and the EPA to review all UNDS discharge standards every five years. Constant review of standards ensures that the Navy will incorporate new pollution control technologies into the UNDS program when proven effective for Armed Forces shipboard use. ⚓

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NAVFAC EXWC Demonstrates New Renewable Energy Power Management Systems

Power Converters Key to Further Reductions in Photovoltaic System Costs

IN AN EFFORT to drive down the cost of using photovoltaic (PV) -generated electricity, engineers from the Naval Facilities Engineering Command (NAVFAC) Engineering and Expeditionary Warfare Center (EXWC) are working on a new kind of power converter.

The project, sponsored by the Office of Naval Research's (ONR) Energy Systems Technology Evaluation Program (ESTEP), is taking an alternative approach to reducing PV system cost. Instead of focusing on the cost of the PV modules and hardware, ESTEP began to look into ways they could leverage recent advancements in power electronics. And in 2012, the program tasked EXWC with exploring ways to reduce the cost of PV inverters, a key part of any PV system.

goal of this project was to acquire a universal power converter that could be applicable to numerous applications. This would increase demand, simplify installation, and provide economies of scale.

Generally speaking, the most common way to manage power conversion in a renewable micro-grid is to bundle multiple inverters and rectifiers (which convert AC to DC) together and use a controller to switch the power flow as needed. However, such a design is expensive and inefficient in terms of conversion losses at each stage, as well as being physically large and heavy. There is a current paradigm shift in how to implement hybrid systems consisting of PV and batteries by making the power converter the central point of connection.

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Inverters & Converters

PV panels produce direct current (DC), but the power grid works on alternating current (AC). Therefore, any PV system requires a mechanism to transform one form of energy into another. In PV systems, this mechanism is almost always an inverter, which performs DC to AC inversion only.

Power converters can convert DC to AC or AC to DC, and have several other advantages over inverters alone. The

Traditionally, power conversion has been achieved using large metal core transformers which step up or down the voltage. Metal core transformers are very efficient and reliable, but they are analogous to an analog system as the world increasingly becomes digital. There are still many legacy PV inverters in service that are built around this technology.

Solid state power converters employ electronic switching circuitry that switches at high frequency which reduces the size of the transformer needed. In essence, solid

state power converters are digital instruments that separate AC signals into DC pulses which are reassembled to the correct AC/DC voltage and current. Solid state power converters are thus more intelligent and flexible in how they convert power. However, because solid state power converters use more electronic circuitry, there are more electronic components which are more sensitive to environmental degradation and failure.

Magnetic components, including transformers, reactors, and inductors are the largest, heaviest and the most expensive components in an inverter. Solid state PV inverters use smaller transistor elements that have achieved a significant cost reduction in PV inverters by reducing the amount of magnetic metal and copper used.

Innovations in Power Electronics

New developments in power electronics such as lower cost microprocessors, longer-life capacitors (which store the electric charge), and more powerful transistors have advanced the development of solid state power converters and enabled them to be more compact, robust and have multi-functionality. This multi-functionality of a single hardware platform is offered by a few startup companies that have introduced new innovative power electronics topologies. One such company is Ideal Power Converters (IPC) which developed a new power converter technology that encompassed many of these advancements.

Conventional power electronic topologies employ a continuous one-way power flow for direct power conversion. The IPC system uses a patented Power Packet Switching Architecture which collects and stores the energy in packets using an AC link and then redistributes them. Conventional power conversion is continuous much like a continuous stream of water. (Note: More about IPC's topology and the advantages it offers can be found at www.IdealPowerConverters.com.)

Another advance in the power electronics field is in the area of control electronics. Control electronics in general is defined as software or hard-

The Basics About ESTEP

ESTEP FOCUSES ON energy technologies that reduce costs, increase energy security, and ultimately increase the reach and persistence of the warfighter. The entire program encompasses the following investment areas:

- Cyber and Energy Management for Information Systems
- Power and Energy Components
- Power and Energy Production/Efficiency

ESTEP
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ESTEP, established in fiscal year 2013, is casting a wide net across the Department of the Navy, academia, and private industry to investigate and test emerging energy technologies at Navy and Marine Corps installations. At present, ESTEP conducts over 20 in-house government energy projects, ranging from energy management to alternative energy and storage technologies. Additionally, an ESTEP Broad Agency Announcement has awarded several contracts to industry in those same energy areas.

In addition to testing and evaluating the performance and reliability of energy technologies, the ESTEP program provides mentoring (via on-the-job training and education of interns) and other workforce development opportunities by partnering with the Troops-to-Engineers program for veterans at San Diego State University and other universities.

For more information on the ESTEP program, visit www.aptep.net/partners/estep. For additional details about EXWC-executed ESTEP projects, visit www.aptep.net/projects/technology/estep-projects/exwc-projects.

The new PV inverter installed at EXWC replaced six older solid state single-phase PV inverters (shown on the right), taking up approximately 30 percent of the footprint of the old system.

Ken Ho

ware that enables complex control of the semiconductor switches and allows for more novel topologies. Improvements in performance and cost of microprocessor controllers, combined with recent developments in digital controls is offering tremendous possibilities from which to create new features, improve performance and offer greater product flexibility. Using software control, the power converter operating characteristics can now be dictated by a stored program rather than a set of discrete components. What this means is that a modern power converter, if designed correctly, can have its function upgraded or changed using software. This makes development of a universal power converter hardware, flexible enough for multiple functions, now feasible.

Photovoltaic Application

To demonstrate the feasibility of one of these systems, a 30 kilowatt (kW) IPC PV inverter was installed in 2015 at Naval Base Ventura County (NBVC) in Port Hueneme, California. This PV inverter had a much higher power density than the solid-state PV inverters installed only a few years earlier. Additionally, the IPC inverter occupied only 30 percent of the footprint of the previous solid state inverters, and 20 percent of the footprint of older metal core inverters.

The IPC inverters were priced at $0.30/watt at the time, in line with other solid state inverter costs, and lower than older metal core inverter costs. More significant savings were realized in labor and materials for installation. Although no exact cost comparisons could be performed for the two inverter setups at NBVC, due to different vendors and periods of installation, it is clear that installation of a single unit would be quicker and less expensive than installing six inverters. Similarly, using larger metal core inverters would have required a fork lift and concrete pad, adding significantly to installation costs. Looking ahead, as more solid state inverters come to market, the price is trending downward.

The Vehicle-to-Grid Charging Station

Under the same ESTEP project, a 60-kW Vehicle-to-Grid (V2G) DC fast charging station was installed at EXWC using two bi-direction battery power converters from IPC. This will enable multi-functionality from a universal hardware platform.

The demonstration not only validated the flexibility of a microprocessor software control approach to power converters, but also provided a new perspective on use of electric vehicles (EV) within the Department of Defense (DoD). The EV is primarily used as a transportation vehicle, but offers a portable electrical energy storage capability as well through its V2G port. The vehicle, manufactured by Phoenix Motor Car, was based on a Ford E450 chassis, converted to all-electric with a 4,000-pound load carrying capacity. The EV has been used extensively for short-run shipping and transportation of large components, and is available without the usual delays associated with

A V2G DC fast charger installed at NAVFAC EXWC in Port Hueneme, California.

scheduling a vehicle through base transportation. The vehicle also has a built-in inverter to provide AC power from its 100-kilowatt hour (kWh) lithium-ion battery modules, through 240- and 120-volt AC outlets. EXWC technicians have been able to load construction equipment onto the truck and perform repair and maintenance in the field without having to worry about the availability of power.

Additionally, the V2G capability of the vehicle can provide building backup power in case of power failure. This feature requires careful planning and an interconnect agreement with the local utility. V2G can also be used to provide ancillary power during peak demand hours—a practice known as peak shaving.

A rebate from the California Hybrid and Zero Emission Truck and Bus Voucher Incentive Program subsidized nearly 50 percent of the EV cost. This brought the price of the EV to a level comparable to a gasoline-powered flatbed truck (with far superior functionality).

Micro-grid

As DoD needs evolve beyond renewable generation toward energy resiliency, more attention is being paid to bi-directional power conversion, and management between load, generation and storage. After some of this functionality was demonstrated with the V2G vehicles, EXWC engineers turned their attention toward using such renewable generation assets on a building.

It comes as a surprise to many facilities owners that PV systems will fail to function when the grid is down. This is because the inverters that accompany a typical PV system serve only a single function—invert DC to AC power and send it onto the grid. When the grid is down, PV inverters are designed to shut off because PV generation is intermittent and cannot provide stable power without a buffer such as the AC grid or an energy storage device.

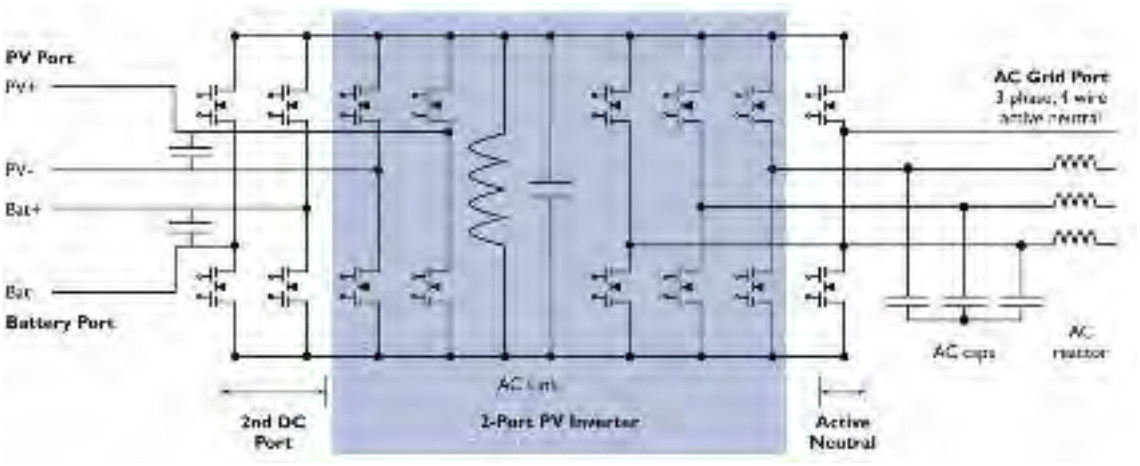
EXWC is continuing with another ESTEP project to install and demonstrate the next phase in PV inverter development—a battery-integrated PV inverter. The 30 kW 3-port hybrid power converter chosen for this project, also manufactured by IPC, was commercially available in 2015. Energy input from any of the unit's ports is stored within the device as "power packets" which can be converted and sent to any of the other two ports via microprocessor control. In this way, a building with installed PV can be converted into a simple building micro-grid. The building micro-grid is scheduled to be installed at an NBVC location in 2017.

Other ESTEP projects are looking at similar converters from this and other vendors.

The Evolving Power Electronics Market

Multi-port inverters/converters are an important component of a resilient energy system. While multi-port inverter products have been around for quite a while, some of these products merely tie multiple converters together on a common bus and package them

EXWC technicians have been able to load construction equipment onto the truck and perform repair and maintenance in the field without having to worry about the availability of power.



The IPC 3-port hybrid power converter topology. The second DC port for the battery input is the same electrical architecture used for the DC port for the PV input. Energy input from any of the ports is stored in the AC link as power packets that gets converted and sent to any of the other two ports. Microprocessor control is critical in executing the complex switching needed to implement this topology.

Ideal Power

together in a single box with controls. These types of designs actually result in higher costs per watt and a very large footprint. As the need to integrate battery storage into PV systems grows, and newer multi-port inverters with smaller size and cost are introduced, there will likely be an increased demand for multi-port inverters.

The IPC converters demonstrated as part of this project illustrate the general trend toward solid state power electronics with microprocessor control. The addition of microprocessor control has enabled unique topologies that were not feasible in the past. Since the start of this project in 2012, more companies have introduced solid state PV inverters with higher power density than PV inverters of five years past. EPC Power Corporation is one such company, harnessing microprocessor technology to produce a 500-kW inverter module small enough to carry under one arm.

As power electronics engineers become more familiar with designing power converters around microprocessor control, newer products are sure to emerge.

Facilities managers should consider the cons as well as the pros of these new systems, however. The reliability of inverters based on solid state switching is inherently less robust than metal core transformer-based inverters, due to the larger number of components and the sensitivity of electronic components to environmental degradation. Reliability can be designed in, but proper design and testing for reliability is more complex for solid state devices and needs to be done correctly to ensure reliability that will exceed 10 years. The market is trending toward smart solid state PV inverters and micro-grid converters. As more investment and time is put into development and manufacturing of solid state power devices, reliability will improve and can potentially match traditional metal core power devices. Already solid state PV inverters manufacturers are offering 10- to 15-year warranties.

Schematic of the building level micro-grid that is planned for an NBVC location.

Microprocessor control using software adds another parameter that has not been fully evaluated. These are a newer class of solid state power converters that is enabling multi-functionality and faster product development. Although these new advances in power electronics can provide flexibility in function, smaller size and lower cost, some facilities users may want to compare warranties or wait until reliability and robustness have been demonstrated over time before adopting them.

At the start of this ESTEP project in 2012, solid state PV inverters with large power capacity (over 30kW), were just beginning to replace larger traditional metal core centralized PV inverters. Currently, the commercial-size centralized PV inverter/converter market is dominated by sales of solid state PV converters, validating part of this project's objective of reducing PV inverter costs by replacing metal core PV inverters with solid state devices. The next phase is to explore possible cost reduction in micro-grid systems with this new class of solid state power converters that use micro-processor controlled switching.

A universal power converter platform that can be achieved with programmable switching has the potential to reduce cost through faster product development and standard power converter hardware. This new class of solid state power converters may not be ready for on-the-field reconfiguration to different applications, but its basic architecture will allow for quick product development and customization at the factory. With this new capability, systems integrators will have more flexibility in designing and implementing power management schemes. Rather than having to piecemeal various converters and selecting the proper power converter for each application, systems integrators can design around a universal platform. Much like car manufacturers using the same engine in various car models to reduce cost and expedite product development, a universal power converter platform can simplify development of power management schemes in micro-grids.

EXWC is exploring this next phase of study under continued ESTEP funding. A building level micro-grid employing these new programmable power converters is under construction at NBVC Port Hueneme. EXWC is also helping installation energy managers at Marine Corps Air Station Miramar and Joint Base Pearl Harbor-Hickam to design and understand the benefits of these newer multi-port power converters in providing a simpler, lower cost solution for integrating renewable energy into micro-grids. ⚓

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Read About ESTEP-sponsored Projects

READ ABOUT THREE other ESTEP-sponsored projects in past issues of *Currents* including "ESTEP Project Studies Data Center Smart Metering Technology" in our winter 2015-16 issue, "ESTEP Sponsors Effort to Protect Critical Data Infrastructures" in our spring 2016 issue, and "NPS Investigates Renewable Powered Heating Ventilation & Cooling with Thermal Storage" in our fall 2016 issue. You browse and download articles from the *Currents* archives on the Department of the Navy's Energy, Environment and Climate Change web site at http://greenfleet.dodlive.mil/currents-magazine.

NAVFAC EXWC Develops Low Impact Development Decision Tool

Software Helps Facilities Maintain NPDES Permit Compliance

THE NAVY IS under increasing pressure from regulators and local communities to reduce the amount of pollutants being discharged into harbors, bays, lakes and streams from stormwater runoff. Many installations must comply with the stormwater requirements associated with the National Pollutant Discharge Elimination System (NPDES) permitting program.

To relieve some of this pressure, engineers from the Naval Facilities Engineering and Expeditionary Warfare Center (NAVFAC EXWC) partnered with personnel from the Low Impact Development (LID) Center with funding provided by the Navy Environmental Sustainability Development to Integration (NESDI) program to produce a stormwater management Decision Support System (DSS). This DSS supports the implementation of LID best management practices (BMP) and is specifically engineered for Navy industrial areas such as scrap metal recycling facilities, motor pools, metal fabrication shops and storage areas.

Low Impact Development Best Management Practices

Knowledge of LID BMPs is a valuable tool for planners and stormwater managers to help reduce particular pollutant loads at their facilities to achieve compliance with their NPDES stormwater permits. Installations are challenged with identifying the best, most cost-effective methods for compliance with NPDES permit limits and benchmarks from both operational and nonindustrial areas.

Stormwater runoff from Navy installations is roughly characterized as having dissolved and/or particulate metals, moderate suspended solids and organic content, and low nutrient and bacterial content. The metal content in stormwater runoff from industrial sites may be attributed to outdoor metal working processes such as cutting and grinding, outdoor storage of metal objects and use of metal bearing materials such as corrosion inhibiting and anti-fouling paints.

The primary contaminants of concern for permit compliance include lead, copper and zinc. The regulatory requirements are typically based on acute and/or chronic toxicity levels, or specific concentrations of the metals in the runoff. Acute toxicity occurs when the concentration can cause severe impacts or be toxic to one or more species, often referred to as indicator species, over a short period of time. Chronic toxicity results when prolonged exposure to the pollutant causes severe impacts or is toxic to an organism or species.

Compliance is achieved through a multi-phase process. An important first step is implementation of non-structural BMPs. Non-structural BMPs are simple, low-cost management

Knowledge of LID BMPs is a valuable tool for planners and stormwater managers to help reduce particular pollutant loads at their facilities to achieve compliance with their NPDES stormwater permits.

The Basics About the LID Center

THE LID CENTER is a non-profit, national research organization that focuses on sustainable stormwater management solutions for urban and developing areas.

LID Center personnel work both independently and in partnership with numerous research organizations, private entities and other non-profit organizations to conduct research, provide concept designs, implement pilot projects, prepare manuals of practice and conduct training.

For more information, visit http://lowimpactdevelopment.org.

practices that reduce the potential for contamination of stormwater runoff.

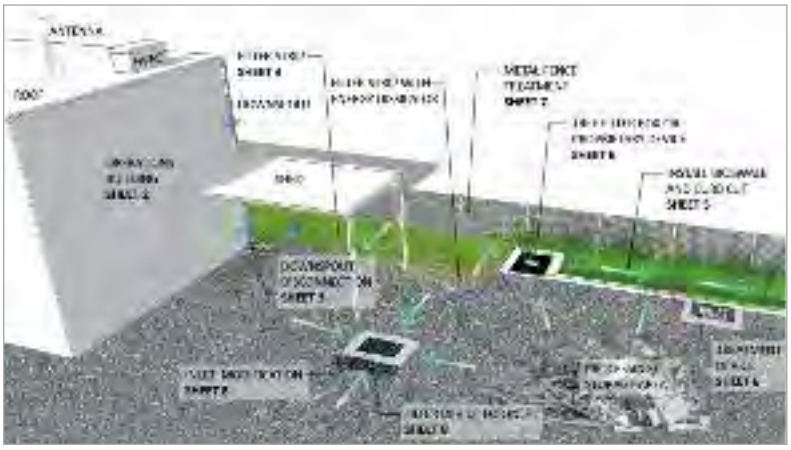
If after all applicable non-structural BMPs have been implemented, contaminants in the stormwater runoff still exceed the permitted discharge limits; treatment of stormwater runoff is required. Treatment measures of stormwater runoff that reduce runoff volume or pollutant concentration are referred to as "structural BMPs."

LID is a land planning and engineering design approach that strives to mimic natural hydrology to capture and/or treat stormwater runoff. LID BMPs are structural BMPs that use natural processes to remove contaminants from stormwater runoff that inherently have low operation and maintenance costs since they typically do not incorporate mechanical devices which tend to require constant maintenance and eventually wear out and break over time. In addition, LID BMPs may be engineered to target problematic metal pollutants and total suspended solids in stormwater runoff from industrial and urban areas.

Cost effectiveness and feasibility for different LID BMPs and locations vary greatly. Some features may be too expensive or cause major disruption to the surrounding landscape.

The stormwater management DSS is organized and presented through a series of flowcharts and templates of typical industrial facilities and potential pollution sources, and potential LID BMP solutions. The application and modification of conventional non-structural and structural BMP approaches may be required for unique physical and operational requirements of Navy industrial activities. A series of templates guide the user through the proper location, configuration and design of the practices. The figure below shows potential industrial area LID BMP options. The following design templates are provided in the stormwater management DSS:

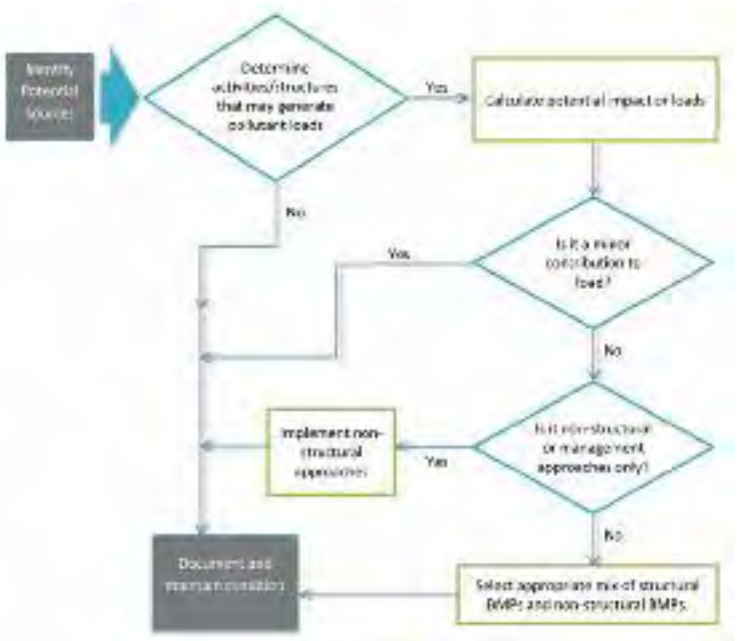
- Sheet 1: Schematic of BMPs
- Sheet 2: Building Improvements
- Sheet 3: Downspout Disconnection
- Sheet 4: Filter Strip
- Sheet 5: Bioswale and Curb Cut
- Sheet 6: Tree Box Filter and Proprietary Devices
- Sheet 7: Metal Fence Treatment
- Sheet 8: Inlet Modification
- Sheet 9: Processing and Storage Area
- Sheet 10: Curb Cut



Schematic of potential LID treatment options.

Removal of pollutants from stormwater runoff is achieved by applying a combination of physical, chemical and biological unit processes.

The stormwater management DSS presents a "common sense" approach for the selection of cost-effective BMPs for reducing heavy metals runoff from industrials areas. The selection of BMPs location, configuration, and design may be an iterative process. The DSS process for stormwater management is illustrated in the figure below.



Stormwater management DSS flowchart.

The treatment of contaminated runoff may be accomplished through combinations of biological, chemical and physical processes. A series of factsheets is provided to the user with detailed information on sizing, design, construction, effectiveness and maintenance of the LID BMPs. Factsheets provided in the DSS include the following LID BMPs:

- Bioswale
- Filter Mat
- Sand/Media Filters
- Permeable Friction Course
- Permeable Pavement
- Vegetated Filter Strips
- Tree Box Filter

Selection of Structural BMP Technologies

A wide range of factors must be considered when selecting structural BMPs. These include, but are not limited to, efficiency of treatment, cost for construction, availability of materials, durability, maintenance requirements and appearance. The user must develop criteria for use at the installation or for the specific activity in order to meet the selection requirements. A series of matrices and tables are used to assist in the selection of BMPs.

Removal of pollutants from stormwater runoff is achieved by applying a combination of physical, chemical and biological unit processes. The table below summarizes the processes that are used to reduce the pollutant load of metals in the dissolved and particulate forms.

TREATMENT PROCESSES

Process	Particulate Metals	Dissolved Metals
Sedimentation	X	
Filtration	X	
Sorption & Ion Exchange		X
Precipitation		X
Complexation		X
Plant Uptake		X

Stormwater runoff will often contain metals in both the dissolved and particulate form. An understanding of the pollutant load and source is critical to the selection of a BMP or BMPs to effectively treat the runoff. In general, the more processes BMPs make use of, the better able they are to remove pollutants down to lower concentration levels.

For More Information

YOU CAN DOWNLOAD a copy of the Stormwater DSS technical report (The Stormwater Management Decision Support System for Using Low Impact Development Best Management Practices in Industrial Areas, TR-NAVFAC-EXWC-EV-1507) from the Defense Technical Information Center at www.dtic.mil/get-tr-doc/pdf?AD=ADA626185.

Sedimentation would initially remove coarse solids such as sand, grit and metal filings, reducing particulate loads. After sedimentation, filtration would provide removal of fine suspended solids. Lastly, dissolved metals can be removed through sorption.

A treatment train of BMPs that employ these three unit processes in sequence is likely to provide effective removal of heavy metals, if each of the components is well designed. The table below lists some common standard LID BMPs that are effective at treating heavy metals and are appropriate for use in industrial areas and their associated unit processes.

Facility Criteria for Selection of BMPs

When selecting a BMP or BMPs for a site, consideration must be given to the particular physical and spatial requirements, potential impact on operations of the

COMPARISON OF THE UNIT PROCESSES EMPLOYED BY LID STORMWATER BMPS

Process	Bioretention	Bioswale	Biofilter	Permeable Pavement	Media Filter	Permeable Friction Course	Compost Filter Mat	Vegetated Filter Strip	Inlet Insert
Sedimentation	X	X				X		X	X
Filtration	X	X	X	X	X	X	X	X	X
Sorption & Ion Exchange	X	X	X		X	X	X		X
Precipitation	X	X	X		X	X	X		X
Complexation	X	X	X		X	X	X		X
Volatilization	X	X	X		X	X		X	X
Microbial Immobilization	X	X	X			X	X	X	X
Microbial Transformation:									
• Ammonification	X	X	X					X	X
• Nitrification	X	X	X	X				X	X
• Denitrification	X		X						
Plant Uptake	X	X				X	X	X	X

RELATIVE PERFORMANCE & REQUIREMENTS OF LID BMPS

BMP	REMOVAL EFFECTIVENESS			EFFICIENCY	
	Metals	Nitrogen	Space	Cost[1]	Maintenance
Bioretention[2]	■	■	■	■	■
Bioswale	■	■	■	■	■
Biofilter	■	■	■	■	■
Media Filter[3]	■	■	■	■	■
Permeable Friction Course	■	■	■	■	■
Compost Filter Mat	■	■	■	■	■
Vegetated Filter Strip	■	■	■	■	■
Inlet Insert	■	■	■	■	■

■ *good* ■ *moderate* ■ *poor*

[1]*Pomeroy and Rowney, 2013*
[2]*Hunt et al, 2012*
[3]*Anguiano and Foreman, 2008*

The Basics About the NESDI Program

THE NESDI PROGRAM seeks to provide solutions by demonstrating, validating and integrating innovative technologies, processes, materials, and filling knowledge gaps to minimize operational environmental risks, constraints and costs while ensuring Fleet readiness. The program accomplishes this mission through the evaluation of cost-effective technologies, processes, materials and knowledge that enhance environmental readiness of naval shore activities and ensure they can be integrated into weapons system acquisition programs.

The NESDI program is the Navy's environmental shoreside (6.4) Research, Development, Test and Evaluation program. The program is sponsored by the Chief of Naval Operations Energy and Environmental Readiness Division and managed by the Naval Facilities Engineering Command out of the Naval Facilities Engineering and Expeditionary Warfare Center in Port Hueneme, California. The program is the Navy's complement to the Department of Defense's Environmental Security Technology Certification Program which conducts demonstration and validation of technologies important to the tri-Services, U.S. Environmental Protection Agency and Department of Energy.

For more information, visit the NESDI program web site at www.nesdi.navy.mil or contact Ken Kaempffe, the NESDI Program Manager at 805-982-4893, DSN: 551-4893 or ken.kaempffe@navy.mil.

facility, as well as capital costs and ongoing maintenance requirements.

The size and drainage area considerations vary greatly due to regional climate conditions and regulatory requirements. State and local government stormwater design and construction manuals often dictate the type and sizing methods that are used for post-construction stormwater management practices. This prescriptive approach is developed to treat a wide range of pollutants. It may be necessary to modify the designs and sizing strategies to allow for more effective treatment of heavy metals. Users should consult state and local stormwater design manuals for more detailed guidance on estimating the size of the facilities.

The size and drainage area considerations vary greatly due to regional climate conditions and regulatory requirements.

Other stormwater management objectives should also be considered when selecting LID BMPs. The table above rates the relative performance, maintenance and lifecycle costs factors that may help DSS users to identify the best solutions to their particular permit requirements.

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DISRUPT THE FUTURE

ENERGY WARRIOR PROFILE

DR. DAN EDWARDS

HOMETOWN: Alexandria, Virginia

AEROSPACE ENGINEER
NAVAL RESEARCH LABORATORY (NRL)

Researchers at NRL and Pennsylvania State University's (PSU) Air Vehicle Intelligence and Autonomy Laboratory demonstrate autonomous soaring algorithms used to keep unmanned sailplanes aloft for sustained flight durations–a benefit aimed at improving the availability of a 24-7 Information, Surveillance, and Reconnaissance mission data.

Courtesy of PSU

> *"An Energy Warrior is someone who is in tune with how much energy they're consuming and actively working to reduce it."*

Q: WHEN DID YOU BEGIN WORKING ON AUTONOMOUS SOARING, AND HOW DID THIS PROJECT BEGIN?

I actually started looking into autonomous soaring topic when I was an undergraduate at North Carolina State University. A few of us were playing pool and eating pizza, when we had this random idea. Someone asked, "I wonder if an autopilot could soar like a bird." Everyone has seen birds flying around with their wings locked. They use rising air currents to stay aloft. So, we wondered, I wondered—could this be done autonomously with a robot?

Cooperative soaring is a similar approach to that which birds use while in flight. When flying, they often look at each other and try to figure out "hey, if my buddy is going up, maybe I should meander in that direction." In our case, we have two airplanes sharing information, and the information gathered by these two planes is then able to give our whole fleet more capability. And that's our end-goal, to increase warfighting capabilities. Since becoming a full-time researcher at NRL, I've focused on the military application—how do you use autonomous soaring to do something useful for a mission that directly supports our warfighters? I've worked out the mathematics to include a propulsion system in the soaring instrumentation and how to accomplish a notional mission with operational altitude and range constraints with soaring active. I've found that using cooperative soaring makes it quicker and easier to find lift and stay aloft.

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Q: WHY DO YOU THINK DEVELOPING A TECHNOLOGY LIKE AUTONOMOUS SOARING IS IMPORTANT FOR OUR WARFIGHTERS, AND FOR WHAT OUR NAVY IS TRYING TO ACHIEVE?

Autonomous soaring is an example of an energy extraction technique that effectively can offset how much weight Marines carry on their back, and reduce the number of takeoffs and landings they have to do with their Unmanned Aerial Vehicles (UAV). Marines want their UAVs to fly longer, to make fewer takeoffs and landings, to carry fewer batteries, and to spend less time on the ground charging. All of those requests come together if the aircraft can extract energy from the atmosphere. Instead of flying on a battery for only two hours, the UAV is able to keep itself aloft by catching thermal updrafts, turning those two hours of endurance into four or six hours. This directly affects our warfighters' operations. In aviation, the primary drivers are vehicle weight and how much payload the vehicle can carry. A large fraction of the takeoff weight is the onboard energy storage in the form of batteries or fuel. Soaring is a perfect way to remove weight from the aircraft and sustain endurance with less power consumption, which could mean more mass for payload or more power available for the payload. Thus, more warfighter capability comes directly from extracting energy out of the atmosphere.

Q: DO YOU THINK A CULTURAL SHIFT TOWARDS INNOVATION/ENERGY CONSERVATION IN THE NAVY IS IMPORTANT? HOW IS NRL PROMOTING THIS IDEA?

Absolutely. I know NRL participates in the Navy Scientist-to-Sea program, where researchers who might not get out from their laboratory environments very often, get to go onto an aircraft carrier or destroyer and see what the Sailors are doing. We are able to talk to them directly and get valuable feedback. When at sea, I get to watch the eighteen-year-old Sailor push buttons and hear him or her say—"This is a really stupid way to do this. Have you guys ever thought about an automatic mode?" That kind of feedback is really important for us scientists to guide our research.

Q: DO YOU HAVE ANY ADVICE YOU WOULD LIKE TO GIVE YOUNG SAILORS, REGARDING INNOVATION AND CREATIVITY?

Personally, I think the people that are closest to the fight are the ones who can give the best feedback. Those are the men and women that should be looking critically at the systems they have, what their future needs are, and communicating those needs up their chain of command. If a Sailor has an idea on how he/she could improve the performance of a system, those are the kinds of ideas that are really important. From the Navy research and development perspective, we really appreciate when Sailors tell us what works and what doesn't. It's the "what doesn't" that really gets our minds going. Some of the best ideas come from people that have the actual problem. Necessity is the mother of invention.

NRL and PSU combined efforts to demonstrate sustained unmanned, powerless flight of two UAV sailplanes during testing of the solar-soaring and cooperative soaring algorithm-based concepts. From left: NRL team members Chris Bovais, Dan Edwards, and Trent Young, and PSU team members Jack Langelaan, Nate Depenbusch, and John Bird.

Courtesy of NRL

Q: WHY IS INNOVATION AND DEVELOPING CUTTING EDGE TECHNOLOGIES SO IMPORTANT?

I think it was the Chief of Naval Research who said, "We don't want it to be a fair fight. The whole point of innovating is to stay ahead of the next guy." So, we have a mandate to innovate. Technology changes so quickly, that unless you're innovating, you're going to fall behind. One goal of NRL is to look ahead at the next five to 10 years. What can we do, what's coming, and what are the next things that we need to invent? I can only speak for my group, but we look very closely at what the hobby community is developing, what academia is developing, and what the rest of the world is developing. We aggregate all of those things together along with our own expertise to come up with directions for new research that stays ahead of the next developments.

Q: WHAT DOES BEING AN ENERGY WARRIOR MEAN TO YOU?

An Energy Warrior is someone who is in tune with how much energy they're consuming and actively working to reduce it. Some things are very simple and straight-forward, like turning off the lights and your computer at night. From the perspective of unmanned aviation, it's more efficiently using the onboard energy stores. In my case, it's finding ways to extract energy from the atmosphere and from the sun, either through soaring or solar photovoltaics, in order to reduce the use of stored energy.

SAILPLANE

Autonomous Soaring for Unmanned Aerial Vehicles (UAVs)

The Naval Research Laboratory (NRL) is testing autonomous, cooperative soaring concepts for UAVs, exploring energy extraction techniques for enabling UAVs to fly longer on less battery power and fuel.

SUPPORTING OUR WARFIGHTERS

UAV energy harvesting is aimed at improving the availability of a 24-7 **Information, Surveillance, and Reconnaissance (ISR) mission** without using logistics fuel. This will benefit the expeditionary warfighter by enhancing the endurance of existing and future UAV assets. Simply put, the UAV collects ISR normally, and autonomously gains energy from the atmosphere when it can.

HOW DOES IT WORK?

NRL's Dr. Dan Edwards tells us that, by locating and using the naturally occurring air currents known as **thermals**, unmanned aerial vehicles can dramatically extend the duration of flight.

LET'S **BREAK IT DOWN**

Communication and data sharing between sailplanes allows each computer to make decisions on where to fly, in order to save energy.

1. **Measures vertical wind**

   Changes in airspeed and altitude are measured. Vertical wind appears as unexpected free altitude.

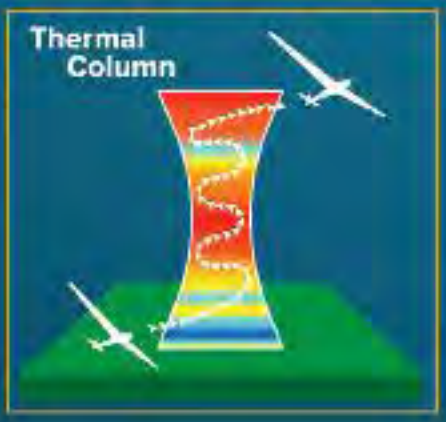
2. **The software**

   The Autonomous Locator of Thermals (ALOFT) algorithm* commands the autopilot to orbit in areas with beneficial vertical winds.

   ** Developed by NRL's Dr. Dan Edwards*

3. **Cooperative autonomous soaring**

   Multiple vehicles can exchange local data of soaring conditions. Using data sharing, the swarm can collectively find thermals more effectively.



It's all about **THE SOFTWARE**

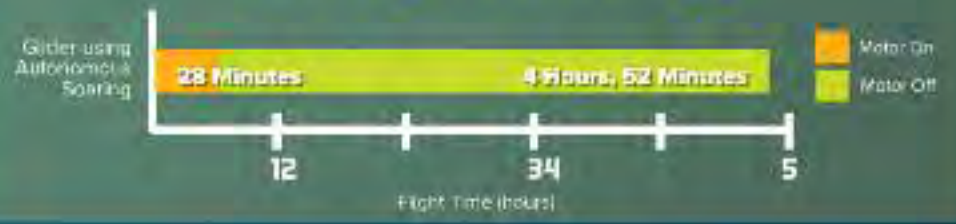
The autonomous soaring technology can be implemented as a software upgrade to any existing UAV autopilots. Initial modeling estimates suggest that a **19 to 20 hour endurance threshold** for a single aircraft is within reach.

TECHNOLOGIES BEING TESTED:

- Photovoltaics
- Autonomous soaring
- High-energy density storage
- Cooperative flight
- Maximum power point tracking (MPPT)

GOAL: To deliver persistent ISR, which operates purely on solar energy.

Improvement with Autonomous Soaring Technology



1,143% increase The aircraft achieved altitudes using thermals to about 5,000 feet

Infographic design by Molly Lisiewicz

SECNAV Announces 2016 Energy & Water Management Award Winners

Program Recognizes Efforts to Support the Mission Through Resource Efficiency

THEN-SECRETARY OF THE Navy (SECNAV) Ray Mabus announced the winners of the 2016 SECNAV Energy and Water Management awards with a high concentration of winners overall in Navy Region Southeast, and the most SECNAV-level winners across the country in Navy Region Southwest.

Announcing the awards via an All Navy message, the SECNAV wrote, "Energy is critical to the Department of the Navy's (DON) ability to provide the global presence necessary to ensure stability, deter potential adversaries, and present options in times of crisis—wherever and whenever they might arise. That is why we are transforming our energy culture—to make us more effective, more agile, and better protected."

"The efforts of the leadership and personnel at the winning commands included developing and implementing energy awareness and behavior change campaigns, deploying energy efficiency technologies, and adopting new operational procedures that optimized our energy use."

Background & Purpose of Awards

The DON's Energy and Water Management awards program is designed to promote and reward excellence in the areas of energy efficiency, energy management, new technology, renewable energy, energy training innovation, and energy awareness. Each year, these awards are presented to those Navy and Marine Corps operational units, installations, and activities that have made notable progress toward DON's goals to reduce energy and water consumption, increase use of renewable energy sources, and construct sustainable facilities. The DON energy program evaluates and classifies the overall energy and water management performance of each installation, ranking them according to a system of SECNAV winner, platinum, gold or blue level of achievement. The 2016 awards recognize achievements made in fiscal year (FY) 2015.

For the 2016 awards, Secretary Mabus announced energy conservation awards for outstanding overall energy performance in each of the following 14 categories:

SECNAV Ray Mabus presents awards for outstanding energy project execution at Marine Corps Base Camp Pendleton. Marine Corps Air Station Miramar, Marine Corps Base Camp Pendleton, Marine Corps Air Station Camp Pendleton, and Marine Corps Recruit Depot San Diego were each presented with SECNAV Energy and Water Management Awards to recognize those Marines, Sailors and civilian employees whose ingenuity and dedication led the way to achieving energy goals and helped change the way the Services think about and use power.

Chief Petty Officer Sam Shavers

SECNAV AWARD WINNERS

The following commands won a 2016 SECNAV Energy and Water Management award:

No.	Category	Winner	Award
1.	Navy Shore Activity Large	NAS Whidbey Island	$40,000
2.	Navy Shore Activity Small	NSA Souda Bay	$25,000
3.	Marine Corps Shore Activity Large	MCB Camp Lejeune	$40,000
4.	Marine Corps Shore Activity Small	MCLB Albany	$25,000
5.	Supported Command Activity	Puget Sound Naval Shipyard & Intermediate Maintenance Facility	$30,000
6.	Surface Combatant (Medium/Large)	USS Nitze (DDG 94)	$25,000
7.	Surface Combatant (Small)	USS Independence (LCS 12)	$20,000
8.	Amphibious (Large)	USS Boxer (LHD 4)	$15,000
9.	Amphibious (Small/Medium)	USS Harpers Ferry (LSD 49)	$15,000
10.	COMNAVAIRLANT Aviation Squadron	Patrol Squadron Five	$25,000
11.	COMNAVAIRPAC Aviation Squadron	Carrier Airborne Early Warning Squadron 116	$25,000
12.	Navy Expeditionary	Underwater Construction Team Two (UCT-2)	$25,000
13.	Marine Corps Expeditionary	2nd Marine Expeditionary Brigade	$25,000
14.	Military Sealift Command Ship	T-AO 187 USNS Henry J. Kaiser	–

1. Navy Shore Activity Large (equal to or greater than 300,000 million British Thermal Units (BTU) of energy consumption during the fiscal year)
2. Navy Shore Activity Small (less than 300,000 million BTU of energy consumption during the fiscal year)
3. Marine Corps Shore Activity Large (equal to or greater than 500,000 million BTU of energy consumption during the fiscal year)
4. Marine Corps Shore Activity Small (less than 500,000 million BTU of energy consumption during the fiscal year)
5. Supported Command Activity (Navy and Marine Corps tenant commands)
6. Surface Combatant (Medium/Large): DDG, CG
7. Surface Combatant (Small): MCM, PC, LCS
8. Amphibious (Large): LCC, LHA, LHD
9. Amphibious (Small/Medium): LPD, LSD
10. Commander, Naval Air Force Atlantic (COMNAVAIR-LANT) Aviation Squadron
11. Commander, Naval Air Force, U.S. Pacific Fleet (COMNAVAIRPAC) Aviation Squadron
12. Navy Expeditionary Unit
13. Marine Corps Expeditionary Unit
14. Military Sealift Command Ship

USS Nitze.
MCS3 Jeremy L. Grisham

SECNAV award winners are authorized to display the SECNAV energy conservation award flag for a period of one year from the date of the award announcement and they will be recognized at a series of award ceremonies to be held over the course of the year.

Award winners and units or activities reaching platinum levels of achievement are authorized to receive cash awards and certificates of achievement. The annual amount and distribution of cash awards will be determined by Navy and Marine Corps energy management. Cash awards may be used at the discretion of the Commanding Officer to improve quality of life, encourage further energy improvements, or for other purposes subject to limitations on the use of operation and maintenance funds.

Navy, Marine Corps, and Military Sealift Command energy management staffs submitted their recommendations based on FY15 accomplishments to the Office of the Deputy Assistant Secretary of the Navy for Energy in accordance with their respective awards criteria. A panel of experts reviewed the submissions and recommended award winners for SECNAV's review and endorsement. The panel evaluated all submissions to determine eligibility for a SECNAV, platinum, gold, or blue level of achievement.

USS Independence.
MC1 Ace Rheaume

2016 Award Winners

The 2016 winners for outstanding overall energy performance achievement in each of the above categories are as follows.

Platinum Award Winners

The Platinum level of achievement indicates an outstanding energy or water program and an exceptional year for energy project execution. The following commands demonstrated platinum level of achievement and all received a $5,000 award:

- NCBC Gulfport
- NS Everett
- NAVMAG Indian Island
- NSY BOS Portsmouth
- JEP Little Creek Fort Story
- Naval Base Kitsap
- Naval Undersea Warfare Center Division, Keyport
- MCB Camp Pendleton
- MCAS Miramar
- USS Benfold (DDG 65)
- USS Sentry (MCM 3)
- USS Kearsarge (LHD 3)
- USS Germantown (LSD 42)
- USNS Alan Shepard (T-AKE 3)

Gold & Blue Award Winners

A gold level of achievement indicates a very good to outstanding energy or water program. The 55 commands that demonstrated a gold level of achievement will receive certificates of achievement. Twenty-four commands demonstrated blue level of achievement which indicates a well-rounded energy or water program. These commands will also receive certificates of achievement.

The efforts of the leadership and personnel at the winning commands included developing energy awareness campaigns, deploying energy efficiency technologies, and adopting new operational procedures that resulted in a consistent reduction in energy or water consumption.

Throughout the fall of 2016, Secretary Mabus visited regions in the continental United States to present commands and squadrons with their 2016 SECNAV Energy and Water Management awards, including:

USS Boxer.
Photographer's Mate 2nd Class Jennifer Swader

- NAS Whidbey Island
- Puget Sound Naval Shipyard & Intermediate Maintenance Facility
- Patrol Squadron Five
- USS Nitze (DDG 94)
- USS Boxer (LHD 4)
- USS Harpers Ferry (LSD 49)
- USS Independence (LCS 2)

During his visits, Secretary Mabus emphasized that using energy efficiency is a combat capability enhancer, "Achieving these goals has made our Navy and Marine Corps stronger by reducing our dependence on fossil fuels and improving our energy security."

"Bravo Zulu to all the winning commands who have served as the model for the rest of the Department of the Navy. I encourage all commanders to look to the accomplishments of our award winners and identify ways that your commands can use energy to its greatest effect," Mabus continued.

"This kind of success doesn't come overnight," said Rear Adm. Rick Williamson, Navy Region Midwest commander. "It takes a well-planned, sustained, and well-executed effort to get results like this, and this level of effort is just what will help the Navy achieve Secretary Mabus' energy goals."

Deputy Assistant Secretary of the Navy (Energy) Joseph Bryan poses for a photo with Capt. Larry Getz, commanding officer the amphibious assault ship USS Kearsarge and its crew. While onboard, Bryan presented Kearsarge with a platinum-level 2016 Energy and Water Management Award.
Seaman Dana D. Legg

USS Harpers Ferry.
MC1 Douglas Bedford

"It was an honor to receive the SECNAV energy award," said Cmdr. Luke Greene, NAVSTA Mayport's public works officer. "This was a reflection of a lot of people's hard work, particularly our Installation Energy Manager Chris Vidal. It also indicated a cultural shift towards energy awareness and a focus on energy conservation."

"Kearsarge maintained excellent records of fuel and water use and ensured that none was wasted by procedural violations or improper plant operation," said ENS Matthew Korte, USS Kearsarge's energy and water consumption representative. "We also drove the ship conservatively, operating at our most efficient bell for the circumstance."

"As members of the Naval Construction Force, we recognize the large scale logistics required to keep a base running, whether as an established installation or in an expeditionary environment. Reducing our energy footprint allows us to put resources where they are needed most," said Lt. Cmdr. Justin Spinks, commanding officer, Underwater Construction Team Two.

"Our ability to keep aircraft in the fight is directly tied to decisions we make every day that affect how much energy we use and how often we refuel. Every kilowatt hour we save makes us more resilient and more able to support the warfighter. The Navy's shore energy approach has three pillars: energy efficiency, culture and behavior, and renewable energy and sustainability. Together, these focus areas will increase our nation's energy security as well as enable the Navy to comply with federal mandates and meet the SECNAV energy goals," said CAPT Howard Wanamaker, commanding officer, NAS Jacksonville.

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Navy Announces FY16 CNO Environmental Award Winners

Annual Awards Recognize Outstanding Environmental Stewardship

VICE ADMIRAL PHIL CULLOM, deputy chief of naval operations for fleet readiness and logistics (N4), announced 30 winners of the fiscal year (FY) 2016 Chief of Naval Operations (CNO) Environmental Awards competition in a naval message in February 2016.

The CNO Environmental Awards are an annual recognition program that highlights the accomplishments of nominated ships, installations, and individuals for exceptional achievements in environmental stewardship. The FY16 winners, listed alphabetically within each category, are shown below.

Natural Resources Conservation, Large Installation

- Naval Air Station Fallon, Nevada
- Naval Air Station Whidbey Island, Oak Harbor, Washington
- Naval Weapons Station Earle, Colts Neck, New Jersey

Environmental Quality, Industrial

- Fleet Readiness Center Southwest, San Diego, California
- Naval Air Station Jacksonville, Florida
- Naval Base Kitsap, Bremerton, Washington

Environmental Quality, Overseas

- Camp Lemonnier Djibouti
- Naval Air Facility Atsugi, Japan
- Naval Station Rota, Spain

Sustainability, Non-Industrial

- Naval Air Station Whiting Field, Milton, Florida
- Naval Hospital Bremerton, Washington
- Naval Support Activity Mechanicsburg, Pennsylvania

Sustainability, Individual/Team

- Naval Base Coronado, San Diego, California
- Naval Base Ventura County Sustainability Team, Point Mugu, California
- NAVSUP Fleet Logistics Center Pearl Harbor, Hawaii

Environmental Restoration, Installation

- Naval Base Point Loma, San Diego, California
- St. Juliens Creek Annex, Norfolk, Virginia

Cultural Resources Management, Small Installation

- Commander, Fleet Activities Yokosuka, Japan
- Naval Air Station Pensacola, Florida
- Norfolk Naval Shipyard, Virginia

Cultural Resources Management, Individual/Team

- Ms. Carrie A. Williams of NAS Pensacola, Florida
- Ms. Kerry A. Vautrot of Portsmouth Naval Shipyard, Maine
- Naval Air Weapons Station China Lake Cultural Resource Team, California

Environmental Excellence in Weapon System Acquisition, Small Program

No nominations received.

Environmental Planning

- Ice Exercise (ICEX) 2016 Environmental Planning Team, Norfolk, Virginia
- Mariana Islands Training and Testing EIS Team, Pearl Harbor, Hawaii
- Transit Protection System Port Angeles Environmental Assessment Project Team, Bremerton, Washington

Afloat *(includes five competitive sub-categories)*

- Littoral or Amphibious Warfare: No nominations received.
- Surface Combatant: USS Monterey (CG 61)
- Large Deck Combatant: USS Harry Truman (CVN 75)
- Submarine: USS Virginia (SSN 74)
- Military Sealift Command: USS Emory S. Land (AS 39)

Winners of the CNO Environmental Awards advance to the Secretary of the Navy level of competition to compete with U.S. Marine Corps nominees.

For more information on the CNO Environmental Awards program, visit http://greenfleet.dodlive.mil/environment/awards.

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2016 Navy Community Service Environmental Stewardship Flagship Award Winners Announced

Commands & Ships Honored That Exhibit Environmental Stewardship Via Volunteer Service

VICE ADM. PHILIP H. CULLOM, Deputy Chief of Naval Operations for Fleet Readiness and Logistics, announced the winners and honorable mentions in the 2016 Navy Community Service Environmental Stewardship Flagship Awards.

The awards program highlights commands and ships that exhibit strong commitment to environmental stewardship via volunteer service projects. The winners are as follows:

Shore command category:

- Small (under 200 personnel): Naval Aviation Schools Command, Pensacola, FL
- Medium (200 to 499 personnel): Pacific Missile Range Facility, HI
- Large (500 or more personnel): Naval Air Station Whidbey Island, WA

Sea command category:

- Medium (200 to 499 personnel): Helicopter Sea Combat Squadron 23, San Diego, CA
- Large (500 or more personnel): USS Frank Cable (AS 40)

Overseas command category:

- Small (under 200 personnel): Navy Munitions Command, East Asia Division, Guam

Commands receiving honorable mentions include:

- Small shore command: Center for Naval Aviation Technical Training Center, Whidbey Island, WA
- Medium shore command: Afloat Training Group San Diego, CA
- Large shore command: Naval Air Technical Training Center, Pensacola, FL

Vice Adm. Cullom applauded the honorees in a naval message. "I extend my congratulations (to the winners) on all of your impressive accomplishments," said Cullom. "Representing the Navy as dedicated stewards of the environment is crucial as we aspire to be good neighbors, afloat and ashore."

This year's winners executed diverse projects such as street, park, and beach clean-ups; partnerships with local community and environmental organizations; recycling efforts; water conservation projects; and others.

Commemorative plaques will be awarded to each category winner, and honorable mentions receive a signed certificate from Vice Adm. Cullom.

The Environmental Stewardship Flagship is one of five flagships that comprise the Navy Community Service program. The four remaining flagships include:

1. Personal Excellence Partnership
2. Project Good Neighbor
3. Campaign Drug Free
4. Health, Safety and Fitness

Sea command category (large) winner USS Frank Cable (AS 40).
Lt. Lauren Spaziano

For additional information about the Navy's energy, environment, and climate change initiatives, visit http://greenfleet.dodlive.mil/home.

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Navy Launches Drug Take Back Program

Program Provides a Mechanism for the Responsible Disposal of Unused Prescriptions

THE U. S. NAVY Bureau of Medicine and Surgery (BUMED), in coordination with the Navy Alcohol and Drug Abuse Prevention Office, has launched a pharmaceutical take back program at Navy pharmacies located in the United States and U.S. Customs territories.

The Military Health System is committed to reducing the risk of prescription and over-the-counter drug abuse in the military community, supporting the Nation's efforts to reduce opioid abuse. This program is intended to provide beneficiaries with a mechanism through which they can responsibly dispose unused, unwanted, or expired prescriptions and over-the-counter pharmaceuticals. Additionally, the program provides appropriate disposal to help minimize environmental impact caused by the flushing of pharmaceuticals into a sanitary sewer or being placed in a landfill untreated with household solid waste.

The collection of these pharmaceuticals through such a program has historically been prohibited by the Drug Enforcement Agency (DEA) under the requirements of the Controlled Substance Act. In lieu of such collection programs, many locations elected to host pharmaceutical take back events that were coordinated with DEA and other local law enforcement agencies. In the fall of 2014, the DEA relaxed the restrictions on such programs to allow DEA registrants to establish permanent take back programs as authorized collection sites.

Now that the appropriate regulatory interpretations and policy waivers have been obtained, Navy pharmacies are authorized to pursue implementation. Department of Defense (DoD) instruction 6025.25 (published April 26, 2016) requires medical treatment facilities to offer drug take back options at qualifying pharmacy locations so beneficiaries can properly dispose of unused, unneeded and expired prescription and over-the-counter medications. Navy pharmacies will be implementing on-site collection receptacles and/or providing mail-back envelopes to provide increased access and convenience to beneficiaries. Additionally, some locations may elect to continue periodic take back events with local law enforcement agencies.

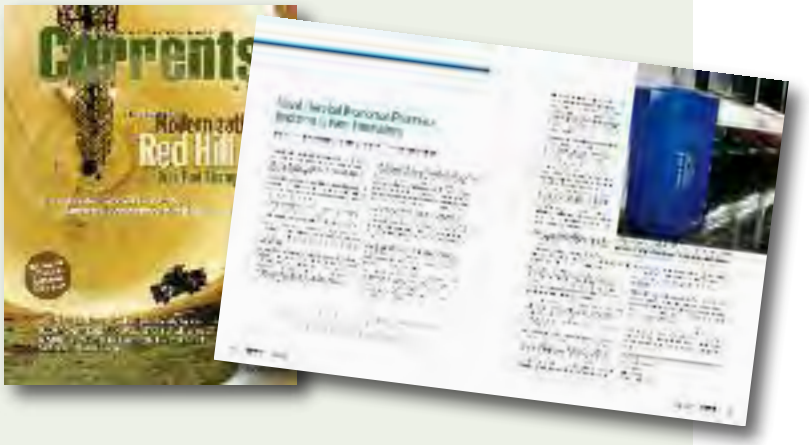
The following items will be accepted via take back programs—prescription and over-the-counter medications, pills, tablets, capsules, ointments, creams, lotions, powders, or liquid medicines (no more than 4 ounces).

Download & Review

TO DOWNLOAD AND review your own copy of the DoD Instruction on the "Drug Take Back Program," visit the Defense Technical Information Center on-line at www.dtic.mil/whs/directives/corres/pdf/602525p.pdf.

For More Information

NAVAL HOSPITAL BREMERTON'S pharmacy has already implemented two programs to safely handle discarded medications and help dispense pre-ordered prescriptions. For more information, read our story "Naval Hospital Bremerton Pharmacy Implements New Innovations" that appeared in the fall 2016 issue of the magazine. You can download this story and browse the entire *Currents* archives at the Department of Navy's Energy, Environment and Climate Change web site at http://greenfleet.dodlive.mil/currents-magazine.



Along with the recognized benefits of using the collection programs, users should keep in mind the following restrictions:

1. The collection programs may not be used for the collection of sharps (e.g., needles or syringes), aerosols, inhalers, illicit drugs (e.g., schedule I controlled substances such as marijuana, heroin, or LSD), chemotherapy or radioactive substances, other hazardous substances (e.g., batteries) or more than 4 ounces of liquid.
2. The beneficiaries must place their own unused, unwanted, or expired pharmaceuticals into the collection receptacle or mail-back envelope. Pharmacy employees and other providers/clinic staff are not authorized to take pharmaceuticals from beneficiaries or deposit the materials into the receptacles or mail-back envelopes on behalf of the beneficiary.
3. The pharmaceuticals must fit entirely within the secured collection receptacle or pre-printed mail-back envelope. The pharmaceuticals cannot be left in the areas surrounding the receptacle and no other packaging for mail-back may be used.

For more information about the options available for pharmaceutical take back, please contact your local Navy pharmacy staff.

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Let's tell your story in *Currents*!

The deadline for our summer 2017 issue is April 21, 2017.

Have some good news about your energy or environmental program? *Currents* is the place to tell your story. *Currents*, the Navy's official energy and environmental magazine, has won first place in the Navy's Chief of Information (CHINFO) Merit awards competition three times. Most recently, the magazine snagged an honorable mention in the last CHINFO competition. It's people like you and the stories you submit that make *Currents* the best magazine in the Navy.

So if you have a story that you'd like to promote in our summer 2017 issue, submit your text and images by Friday, April 21, 2017. Any submissions received after this date will be considered for our fall 2017 issue.

You can get a copy of the *Currents* article template by sending an email to Bruce McCaffrey, our Managing Editor, at brucemccaffrey@sbcglobal.net. This template has proven to be a tremendous asset in helping us edit and track your article submissions. Bruce is also available at 773-376-6200 if you have any questions or would like to discuss your story ideas. And don't worry. If writing isn't one of your strengths, we'll handle all of the editing necessary to get your submission into publishable form.

As a reminder, your Public Affairs Officer must approve your article before we can consider it for inclusion in the magazine.

Don't forget to "like" us on Facebook at www.facebook/navycurrents. *Currents*' Facebook page helps expand the reach of the magazine and spread the news about all the great work you're doing as the Navy's energy and environmental guardians.

Currents Deadlines

Summer 2017 Issue: Friday, April 21, 2017
Fall 2017 Issue: Friday, July 21, 2017
Winter 2017-18: Friday, October 20, 2017
Spring 2018: Friday, January 19, 2018

You can also refer to your 2016-18 *Currents* calendar for reminders about these deadlines.

NESDI Program Launches New Initiatives

Notable Efforts Include Improved Aircraft Engine Washing & Contaminated Sediment Strategy

THE NAVY ENVIRONMENTAL Sustainability Development to Integration (NESDI) program launched 15 new initiatives in fiscal year (FY) 2016 to address some of the most pressing environmental operational challenges facing the Navy. These projects seek, among other objectives, to demonstrate a new, more efficient engine washing procedure for use across the Naval Air Systems Command (NAVAIR) and develop a comprehensive investment strategy for contaminated sediment management.

Each year, the NESDI program collects environmental needs from across the Navy's shore community. Based on selected needs, project teams are formed to demonstrate, validate, and integrate innovative technologies, processes, and materials into fleet operations. In FY15, after a total of 62 needs were collected and 25 proposals to address those needs were received and reviewed, the program gave the green light to the following 15 projects:

1. Stable Carbon Isotopes for Tracing In Situ RDX Remediation (project no. 537)
2. Development of Advanced Primer and Superhydrophobic Topcoat for Corrosion Resistance and Leachate Impedance (project no. 538)
3. Forward Looking Infrared (FLIR) for Advanced Discharge Characterization (project no. 539)
4. Smart Electronic Tools for Navy Environmental Compliance Monitoring and Reporting (project no. 540)
5. Utility Vault Water Treatment (project no. 541)
6. Naval Air Systems Command Solutions for Engine Washing (project no. 542)
7. Preventative Management of Contaminated Silt (project no. 543)
8. Stable-Isotope Labeled Tracers, an Innovative Way to Validate Natural Attenuation of RDX in Groundwater (project no. 544)
9. In Situ Treatment of 1,4-Dioxane Using Enhanced Biodegradation (project no. 545)
10. National Pollutant Discharge Elimination System (NPDES) Copper Effluent Control System (project no. 546)
11. Demonstration of Improved Toxicity Methodology to Link Stormwater Discharges to Receiving Water Impacts at Navy Sites (project no. 547)
12. Sewer Gas Elimination Technology (project no. 548)
13. Demonstration of Optimized non-NMP (n-Methyl-2-pyrrolidone) Solvents for Immersion Chemical Depainting (project no. 549)

If provided with a scientific method for determining RDX degradation rates over site-specific spatial and temporal scales, site managers could more confidently implement successful remediation approaches.

14. A Comprehensive Analysis and Strategy for Contaminated Sediment Management (project no. 550)
15. Impact of Sediment Resuspension by Propeller Wash and Ship Induced Hydrodynamics on Remediation Options (project no. 551)

Stable Carbon Isotopes for Tracing In Situ RDX Remediation (project no. 537)

Munitions explosives contamination continues to concern Department of Defense (DoD) facilities, costing considerable resources in time and money for assessment, cleanup, monitoring and site closure. Acceptable limits of RDX (cyclotrimethylene-trinitramine) are very low, making accurate contaminant degradation measurements a high priority for site managers. If provided with a scientific method for determining RDX degradation rates over site-specific spatial and temporal scales, site managers could more confidently implement successful remediation approaches.

Most assessment methods for degradation rate estimation are based on indirect measures. These "lines of evidence" approaches are expensive and have little forecast capability. They fail to conclusively determine which of many factors and conditions are responsible for the degradation of RDX into its desired end product—carbon dioxide (CO_2).

A natural abundance isotope ratio mass spectrometer—designed to work at per mil (1 in 1,000) resolution—will detect shifts in the CO_2 and CH_4 stable isotope ratios as RDX is degraded to these end-products. Sampling will be conducted seasonally and spatially for dissolved inorganic carbon (CO_2), dissolved methane (CH_4) and bacterial biomolecules in groundwater and if possible, soil. The sum of these measurements can determine the total degradation of RDX by natural methods (attenuation).

The end result of this project will be a protocol usable at sites with either engineered or natural attenuation remediation programs currently in effect. The team will develop a seminar to highlight the results of this project and resultant methodology and deliver it to affected Remedial Project Managers, regulators and other stakeholders.

Development of Advanced Primer and Superhydrophobic Topcoat for Corrosion Resistance and Leachate Impedance (project no. 538)

Galvanized metal is commonly used at Navy installations. This metal is also one of the main sources of zinc in stormwater discharges, and one of the primary reasons for potential regulatory compliance issues. Both the Navy and the Electronic Harbor Security Systems (EHSS) program

A FLIR camera can provide thermal imaging of the environment.

The goal of this project, headed by Thomas Boyd of the Naval Research Laboratory, is to differentiate contaminant-derived CO_2 from CO_2 produced by the soil's natural respiration processes. The general approach is to target the contaminant's carbon backbone using isotopic analyses the most common being stable carbon analysis. This type of analysis has been employed by the Naval Research Laboratory to detect chlorohydrocarbons and munitions constituents in contaminated plumes at other DoD sites.

Carbon-13-labeled RDX will be released as a tracer into the groundwater at a U.S. Navy site (or sites). RDX with Carbon-13 is traceable into soil gas CO_2 and methane, under both aerobic and anaerobic conditions. Preliminary discussions have identified a site at Naval Base Kitsap-Bremerton Washington. This site meets many of the conditions that make it appropriate for a demonstration, and the site has regulator approval to release small amounts of RDX.

have a stake in protecting these galvanized structures and reducing zinc in stormwater runoff.

The EHSS has responsibility for over 60 sites worldwide with galvanized metal structures that are regularly subject to heavy salt spray which results in rapid corrosion. This can cause both zinc leaching and discharge, increased structural repair due to corrosion, potential damage to security equipment and potential downtime.

This project was formed as a partnership between EHSS, the Naval Air Warfare Center (NAWC) Patuxent River, Maryland and the Space and Naval Warfare Systems Center Pacific (SSC Pacific) in San Diego, California. The team, headed by Brandon Swope of SSC Pacific, and Alan Grieve of NAWC Patuxent River, will investigate two potential solutions to this problem—superhydrophobic coatings and inorganic zinc-free primers.

Galvanized metal is one of the major sources for zinc runoff in stormwater.
Chuck Katz

Volumetric superhydrophobic coatings are water-repelling coatings first developed by the oil industry. These coatings have undergone extensive testing for their anti-corrosion properties and showed no leaching whatsoever, making them far superior to any other coatings currently or previously in use. Superhydrophobic coatings are also considered a "green" technology because they're not biocidal and virtually eliminate zinc leaching.

Metal-rich coatings have proven to be highly effective in preventing corrosion in aggressive corrosion environments. Most of these products contain a zinc pigment, which leaches out into the environment. This type of pollution in estuaries and bays is a problem that can affect marine life. Zinc-free alternative coatings have been developed by personnel from the Naval Air Systems Command. These inorganic coatings have produced good results in accelerated testing and may provide an alternative to zinc-based corrosion prevention schemes while limiting heavy metal discharge.

Laboratory testing of the two products will be conducted at NAWC Patuxent River and SSC Pacific. After a suitable formula has been identified, field-deployed test panels will then be sent to various EHSS testing sites (based on operational availability) where high levels of corrosion occur, and assessed for corrosion in these environments over

time. Additionally, scaffolding material will be coated and

field deployed in an industrial shipyard setting

End users at EHSS will be involved with the demonstration of the product, and if successful, they will adopt the technology worldwide. Additionally, Navy facilities with permit-

ting issues related to zinc leachate will be engaged during the project with the end goal being to include the product in future contractor requirements to apply these new coatings during the maintenance of galvanized structures.

Forward Looking Infrared (FLIR) for Advanced Discharge Characterization (project no. 539)

A mixing zone is an area in a water body immediately adjacent to a discharge outfall. Discharges may result from stormwater or other industrial activities such as cooling water. A mixing zone is defined by the U.S. Environmental Protection Agency (EPA) as an "allocated impact zone where numeric water quality criteria may be exceeded as long as acutely toxic conditions are prevented." Put simply, higher levels of metals and other contaminants are allowed in this zone, with the assumption that they will become diluted within the larger water body.

Hydrodynamic models have been developed to characterize the potential concentrations of contaminants and toxicity of these mixing zones; however they are not designed to address the issues of dynamic mixing for pierside/nearshore surface discharges (e.g., stormwater mixing).

It is the goal of this project, headed by Brandon Swope of SSC Pacific, to provide a means to better and more easily quantify and characterize a dynamic mixing zone as well as provide more data for these models through the use of a new technology. This will allow for the better linking of small and large scale hydrodynamic models.

A FLIR camera can provide thermal imaging of the environment, which can aid in developing highly accurate data associated with outfall discharges. FLIR cameras are currently used for a wide variety of applications,

A FLIR camera can provide thermal imaging of the environment, which can aid in developing highly accurate data associated with outfall discharges.

including crop analysis, animal physiology and law enforcement.

The camera records temperature differences between the discharge and ambient water, and its fine scale data resolution can adequately record the mixing patterns in structurally complex pierside regions. A validated model utilizing this technology will enable advanced discharge characterization at Navy facilities to meet National Pollutant Discharge Elimination System requirements.

After calibrating the FLIR camera, the project team will demonstrate the utility of FLIR cameras to capture the dynamics of multiple shoreline discharges, and will incorporate FLIR data into three current hydrodynamic models.

EPA supports the use of advanced discharge models that integrate the concepts utilized in this project. Adding additional capabilities to the suite of hydrodynamic models currently used by the Navy (Curvilinear-grid Hydrodynamics 3D (CH3D), CORMIX mixing zone, and Dynamic Mixing Zone models) will strengthen support for and adoption of these models.

Smart Electronic Tools for Navy Environmental Compliance Monitoring and Reporting (project no. 540)

The Department of the Navy is required by EPA to perform compliance monitoring of Navy activities for 44 programs, including stormwater discharge and spill response. Establishing an efficient compliance program requires collection of massive amounts of data. Comprehensive field surveys of Navy installations require several teams of surveyors, each having varying degrees of experience, note-taking habits, penmanship and very limited time. For example, cross connection surveys (surveys of points where potable and non-potable water sources meet) involve labor-intensive activities including field collection of data, review and manual tabulation of data into spreadsheet or database format, resolving discrepancies in identification of hazard types and identifying corrective actions required. Compilation and interpretation of field notes, manual tabulation of data and consistency checks for hundreds of buildings following these surveys are time-consuming tasks. In addition, handwritten data has to be transferred into a digital format.

Many commercial off-the-shelf technologies exist that assist Public Works Departments in collecting data digitally in the field and transferring it to the work station. However, there is an information gap on what electronic devices are acceptable and compatible with the Navy Marine Corps Intranet (NMCI). This project, headed by Itzel Godinez of the Naval Facilities Engineering and Expeditionary Warfare Center (NAVFAC EXWC), was formed to identify a user-friendly electronic device and software that are currently NMCI-compatible, or could be certified to be NMCI-compatible.

Most field surveys in the Navy are done with pen and paper.
Daniel P. Jackson Norgart

Although integrating a new technology into the NMCI network can be burdensome and time-consuming, this hurdle should not immediately exclude this project. If the technology is successfully integrated into NMCI, end users would reap the benefits indefinitely.

The project team will first seek feedback from the public works department at Naval Base Ventura County (NBVC) in Port Hueneme, California to determine the needs of the user community. Then a market technology survey will be undertaken, and the top two technologies will be

The EcoPower system produces better results, in less time, with greater efficiency, without the associated hazardous waste disposal issues.

delivered to NBVC for feedback. The technology with the most potential will be demonstrated on a small scale at the base. If the demonstration is successful, a statement of work (SOW) will be completed that includes the technology specifications and cost information. The SOW can be then used by any Public Works Department to acquire the technology.

Utility Vault Water Treatment (project no. 541)

All Navy shoreside facilities have a system of underground vaults which provide access to utility systems. These vaults accumulate rainwater and groundwater, which can be contaminated through surface runoff, or through contact with lubricants, oils and rust within the vaults themselves. The accumulated water in these tunnels must be removed if it interferes with maintenance work, and occasionally, to prevent discharge to surrounding waters. Under the National Pollutant Discharge Elimination System (NPDES), this contaminated water is subject to the facility's permit, which requires the installations to generate and comply with a Pollution Prevention (P2) plan. Naval Base Coronado's (NBC) P2 plan includes measures to route pumps and hoses to the local sewer service for manual dewatering, requiring extensive labor and logistical support to set up. Dewatering a utility vault and discharging the accumulated water to the sanitary sewer requires the use of a network of portable pumps or a vacuum truck, resulting in delays when this equipment is not readily available.

This project, led by Pat Morrow of the Naval Surface Warfare Center, Carderock Division, will demonstrate a Hydrocarbon and Contaminants Removal (HCOR) device which has been developed specifically for utility vault dewatering. The HCOR device is a compact filter installed on the outflow of the vault's sump pump prior to discharge. The HCOR device utilizes fine-grain media for hydrocarbon and suspended solids removal. While much of the total contamination will be removed through this filtration media, more robust, chemically reactive measures will be added to reduce the fraction of dissolved metals even more. Additionally, other metal-specific adsorbents will be evaluated for suitability as a finishing or "polishing" step in this process. The combination of these technologies can ultimately prolong the life of the ion exchange media, and meet increasingly stringent discharge requirements.

The demonstration will include the evaluation of the HCOR filtration device along with polishing steps during normal dewatering of the utility vaults located at NBC. This demonstration will include appropriate sampling and analysis to determine the improvement in effluent quality resulting from the use of the following:

- The stock HCOR device on its own.
- The HCOR device with the addition of enhanced metals removal.
- The HCOR device coupled with adsorbent media as an alternative solution to remove metals.

A typical utility vault onboard a Navy installation.

Naval Air Systems Command Solutions for Engine Washing (project no. 542)

NAVAIR maintenance operations require engine washing as a routine part of scheduled maintenance. Current engine washing procedures require the use of a gas path cleaner, which requires thorough rinsing. Occasionally, the rinsing process is insufficient, and dried residual cleaning solution remains in and on the engine. This attracts dirt and contaminants, and can lead to bearing pitting/corrosion, and water migration into the oil—all of which require subsequent maintenance.

The equipment and processes used at Fleet Readiness Centers (FRC), Naval Air Stations, and other maintenance facilities lead to excessive amounts of water usage and insufficient cleaning. In addition, these systems use osmosis water purifiers in combination with mixed bed deionizers. Workers—particularly outside the U.S.—often do not have access to water of sufficient quality; instead using locally available potable water, which rarely meets requirements. Without deionized water, engine washing quality is compromised. Inefficient engine washing operations potentially lead to hazardous waste generation and greater hazardous air pollutant emissions due to excess fuel burning and excess fuel consumption.

This project team, led by Keiko Sapp of FRC East in Cherry Point, North Carolina and Kami Downey of FRC Southeast in Jacksonville, Florida, plans to demonstrate EcoPower™—a cleaning technology that uses heated, deionized, atomized water along with custom manifolds for specific aircraft/engine types to clean the engine. EcoPower is used extensively worldwide in the commercial aviation industry.

This NESDI project is demonstrating a new engine washing procedure for use across NAVAIR. Shown here is an H-53 helicopter engine wash demonstration with the EcoPower small wash unit and effluent collecting kit in place.
David Marriott

This technology works by delivering high-pressure water through a manifold in a droplet size tailored to the engine type. The system deionizes the input water, so any fresh water source is acceptable. At the end of the cleaning process, the effluent is captured, recycled, and cleaned of metal contaminants in a nearly closed-loop system. Recycled water can be analyzed and monitored for contamination buildup to determine when it should be disposed.

Detergent is not required for this system, thus eliminating the challenges associated with detergent buildup, as well as purchasing costs and handling/storage concerns. Additionally, the proposed technology takes about 40 to 60 minutes per aircraft to complete, as opposed to roughly 4–8 hours per aircraft for the current procedure.

In short, the EcoPower system produces better results, in less time, with greater efficiency, without the associated hazardous waste disposal issues and no need for a deionized water supply. The initial phase of this project involves customizing the system for various aircraft platforms including the V-22 Osprey tiltrotor aircraft, H-53 Sea Stallion helicopter, AV-8 Harrier vertical/short takeoff and landing jet aircraft, P-8 Poseidon military patrol aircraft, and C-130 Hercules military transport aircraft. This will be followed by demonstration, performance testing (including an estimation of the hazardous material and hazardous waste handling costs), industrial validation and integration into existing operations.

After successful execution at land-based activities, additional

demonstrations will be conducted in a shipboard environment. Then, the appropriate technical maintenance manuals including the Cleaning and Corrosion Control Manual (NAVAIR 01-1A-509) and the Maintenance Instructions (Organizational and Intermediate Level) Support Equipment Cleaning, Preservation, and Corrosion Control Manual (NAVAIR 17-1-125) will be revised.

Preventative Management of Contaminated Silt (project no. 543)

Sediment contamination in the waterways surrounding Navy facilities may require costly cleanup efforts and operational disruption. Sediment containing contaminants may be found in drydock discharge and process streams. Once this sediment is introduced into the process stream—through the intake of seawater during docking operations—it is managed through cleaning efforts requiring extensive labor and potential delays to industrial work on the ship in dock. Current methods of managing contaminated sediment before reaching the drydock in surrounding waterways are limited to techniques such as dredging and capping, which are expensive and can be operationally and environmentally disruptive.

This project will demonstrate passive sediment collection and dewatering devices that will trap contaminated sediment before it is deposited on the drydock floor, thereby reducing the contaminant waste stream as well as the time and effort needed for drydock cleaning. The devices will be demonstrated at the Puget Sound Naval Shipyard & Intermediate Maintenance Facility (PSNS & IMF) under the leadership of Pat Morrow, Naval Surface Warfare Center, Carderock Division.

The devices chosen for demonstration are clarifying inserts which can be placed into the existing sand traps to capture and retain sediment during drydock flooding and dewatering. A sloped or conical bottom shape coupled with piping connections will allow the inserts to be quickly and effectively flushed out for removal and disposal of silt.

Part two of this demonstration will be the collection of sediment from the area of accumulation outside the drydock apron. This process will precede drydock flooding, reducing the amount of silt that would otherwise flow into the dock when the caisson is removed. Following an initial feasibility study and proof of concept testing, it is expected that this will be accomplished through targeted high solids pumping and recovery devices similar to those used in dredging, but on a much smaller scale.

These two targeted methods of sediment retention bridge the gap between disruptive, expensive, large-scale dredging and capping projects and the time-consuming, inefficient ground crew cleanup that occurs between docking completion and commencement of industrial work.

Once a successful design of the dewatering and sediment removal equipment is demonstrated, additional facilities and additional drydocks at PSNS & IMF will be addressed. The design will allow for the customization of equipment needed for each PSNS & IMF drydock and other Navy drydocks.

Propane is injected into the saturated zone to increase the biological activity of the indigenous microorganisms.

Stable-Isotope Labeled Tracers, an Innovative Way to Validate Natural Attenuation of RDX in Groundwater (project no. 544)

The Navy has multiple sites impacted by munitions explosives contamination. Acceptable limits of RDX (cyclotrimethylene-trinitramine)—the main contaminant of concern—are very low, making site closure difficult to attain when sites have to meet strict cleanup goals. Many Navy installations with RDX groundwater have active remedies in place, such as pump and treat systems, to mitigate any risks associated with these plumes. Active remediation systems tend to have high operating and maintenance costs, and the persistence of RDX tends to limit their overall effectiveness. Often, sites rely on natural attenuation processes to achieve the site-specific remediation goals; however, it is difficult to demonstrate that natural attenuation really is occurring and at what rate.

Headed by Jennifer Segura of NAVFAC EXWC, this project team will conduct a field demonstration based on a

The proposed demonstration site at Naval Base Kitsap Bangor.

technology developed under the Strategic Environmental Research and Development Program (SERDP). This approach uses a stable isotope method for tracking RDX in situ to validate that natural attenuation is occurring and at what rates.

Small natural variations in the composition of isotopes (atoms with small but detectable variations in mass) have proven useful for examining contaminant sources, transport, and processing, particularly in groundwater environments for a variety of contaminants. However, because natural variations in isotopes are small and can arise for several reasons, this method can be an ambiguous tool to attribute sources or calculate transformation rates. In contrast to relying on natural variations in isotopic enrichment, adding an isotope to a contaminant (known as isotope labelling) provides clear source tracking. This technique can uniquely identify the products of RDX degradation, whether they are organic derivatives or true products of complete mineralization the latter constituting natural attenuation.

This project team will introduce a stable isotope-labeled contaminant (RDX) into an existing RDX plume to trace the fate of the parent RDX in the environment.

The demonstration is proposed to take place at Naval Base Kitsap Bangor. The well-established "push-pull" technique will be used to introduce stable isotope-labeled ^{15}N-RDX into the RDX plume. The plume will be monitored for production of RDX mineralization products containing the ^{15}N tracer. Natural attenuation rates will then be calculated from these measurements. This demonstration will provide substantial data that can be utilized to transition sites from active to passive remediation with regulator acceptance.

The project's final report will be distributed to Remedial Project Managers for those sites impacted by RDX. Results of the project will also be discussed with relevant working groups and presented at major conferences.

In Situ Treatment of 1,4-Dioxane Using Enhanced Biodegradation (project no. 545)

The DoD has over 100 sites with measureable concentrations of 1,4-dioxane in their groundwater, and many of these have high enough concentrations to require treatment. Although a number of potential remedies have been examined, these all tend to be either prohibitively expensive or ineffective, and the Navy does not have a cost-effective solution that can be implemented immediately.

The objective of this project is to demonstrate a new, cost-effective treatment method for reducing or removing concentrations of 1,4-dioxane from groundwater at Navy sites.

Enhanced in situ aerobic bioremediation is the process of stimulating indigenous oxygen-dependent microorganisms to degrade contaminants in groundwater and in the aquifer matrix. Bacteria with the capacity to biodegrade 1,4-dioxane are augmented with auxiliary substrates to induce the required enzymes and support co-metabolic degradation.

Preliminary studies have revealed propane biosparging to be effective for bioremediation of 1,4-dioxane. Biosparging technology uses indigenous microorganisms to biodegrade organic constituents. In this process, propane is injected into the saturated zone to increase the biological activity of the indigenous microorganisms. If necessary, oxygen and nutrients are also injected to make for ideal conditions for biodegradation.

This project team, headed by Timothy Appleman of NAVFAC EXWC, plans to leverage the results of treatability

Real-time multi-level monitoring of remedial amendment injection.
GSI Environmental, Inc.

studies conducted at Rice University on a separate project. The most promising bacteria strains identified in these studies will be fermented and characterized by their suitability for production scale-up.

The project will then move into the pilot test phase. The design of the pilot test will be tailored to meet the characteristics of the selected test site. The general structure of the pilot test will involve the injection of an amendment solution consisting of a tracer plus a co-metabolic substrate into a well or wells. At a nearby well(s), an amendment solution consisting of a tracer, co-metabolic substrate and a bioaugmentation culture will be injected. Consequently, this design will provide data to compare biostimulation with bioaugmentation. Postinjection monitoring will occur periodically through a series of groundwater extractions from test well(s). The success of the demonstration will be tied to decreasing concentrations of 1,4-dioxane, and the transformation capacity and rates which will help determine the feasibility of designing a full-scale in situ biostimulation system.

National Pollutant Discharge Elimination System (NPDES) Copper Effluent Control System (project no. 546)

Over the past several years, regulatory levels for copper in stormwater runoff have become more stringent across the country. Meeting these requirements is particularly problematic at Navy shipyards and drydocks where multiple point and non-point sources of copper exist. In addition, effluent levels vary temporally, and are especially sensitive to rain events, which triple effluent concentrations. National Pollutant Discharge Elimination System (NPDES) -regulated copper concentrations are based on total copper, which includes all forms (dissolved and bound). Most copper in runoff is in the form of the bound or particulate forms, which are less bioavailable and less toxic than the aqueous (dissolved) form. Conversion of the more toxic forms of copper to the less toxic forms can be environmentally protective, but its regulatory utility has not yet been adopted in some Navy locations.

The ability to measure all forms of copper and demonstrate how much of the metal is bioavailable will aid with analysis of NPDES levels.

As each shipyard has its own unique conditions, no single treatment technology will be able to cost effectively clean all shipyard and drydock effluents. This project team, led by Iryna Dzieciuch of SSC Pacific, will demonstrate an automated approach to selecting appropriate technologies and monitoring their effectiveness.

The Navy Copper Analyzer (NCA) is the latest generation of automated real-time copper analyzers developed at SSC Pacific and demonstrated under the NESDI program and the Environmental Security Technology Certification Program (ESTCP). The NCA is the only instrument capable of measuring all three forms of copper (whole, dissolved and bound) in effluents, in situ and in near real-time at environmentally-relevant concentrations.

The use of pulsed (intermittent) toxicity exposures has been documented in several studies as an effective way to characterize toxicity in water bodies.

This precise real-time control system is also capable of [illegible] [illegible] will also be capable of measuring and controlling the [illegible]

The NCA will be laboratory tested and field tested at Pearl Harbor Naval Shipyard & Intermediate Maintenance Facility, where the regulatory level is many times lower than current discharge levels. Grab samples will be collected and measured using approved EPA methods. These results will be compared with the field readings of the NCA.

The Navy Copper Analyzer.

Demonstration of Improved Toxicity Methodology to Link Stormwater Discharges to Receiving Water Impacts at Navy Sites (project no. 547)

The Navy is required to comply with increasingly stringent water quality requirements associated with industrial stormwater discharges. These requirements generally specify end-of-pipe monitoring. However, this type of monitoring—measuring contaminants at the outfall point—is problematic because the exposure conditions at the end-of-pipe are not static. Also, this type of monitoring does not account for the changing magnitude and extent of exposure when contaminants mix in the larger body of water.

One commonly used test method, Whole Effluent Toxicity (WET) testing, was developed to provide a better picture of continuous point source discharges by taking into account factors such as contaminant bioavailability, and some of the complex effects associated with exposure to multiple contaminants, many of which may not be monitored. However, WET methodologies still assume continuous discharges, likely overestimating the toxicity associated with the infrequent and episodic nature of stormwater discharges.

This project plans to identify a more environmentally relevant approach to assessing stormwater toxicity by taking into account actual exposure conditions both at the end-of-pipe and in the receiving water.

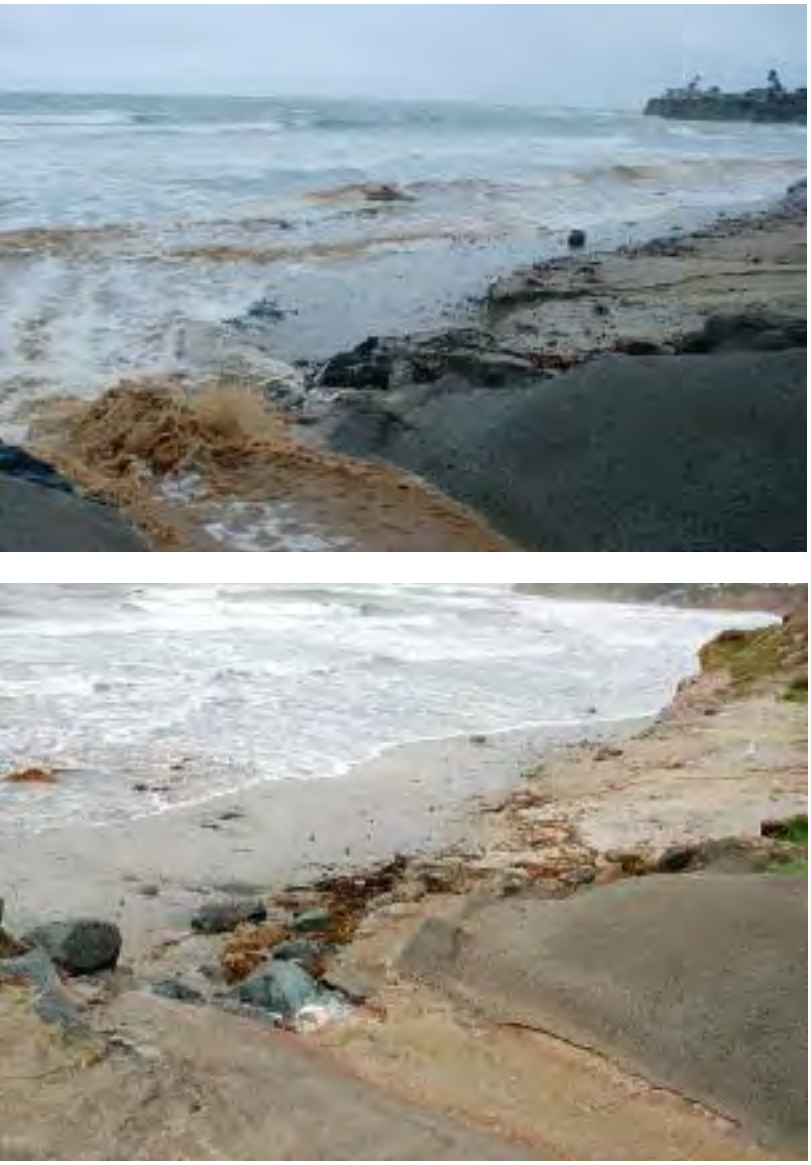
The use of pulsed (intermittent) toxicity exposures has been documented in several studies as an effective way to characterize toxicity in water bodies, in part because pulsed exposures are more characteristic of real-world conditions.

The team, led by Marienne Colvin of SSC Pacific, will leverage work already sponsored by the NESDI program and others to gather historical data on rainfall and mixing zone dynamics at several DoD facilities. These data, and the results of other pulsed toxicity studies, will be used to conduct laboratory testing using relevant contaminants of concern and permit-relevant species.

Concurrent end-of-pipe monitoring and in situ water body monitoring will then be initiated, using passive Sediment Ecotoxicity Assessment (SEA) ring samplers. Using the data gathered in the first two steps as a guide, exposures will be varied by time and concentration. The goal is to

paint a more accurate, scientifically defensible picture of real-world stormwater discharges and their impact on the water body.

At the end of the project, a user's guide will be produced for permit writers and Navy water quality managers. The development of a final report will also be coordinated with the San Diego Regional Water Quality Control Board to seek regulator acceptance of the technology.



Stormwater discharge at the onset of a rain event (TOP) and less than 24 hours later (BOTTOM) showing episodic nature of events at end-of-pipe and in the receiving environment. This project will demonstrate and validate a more accurate exposure design for laboratory toxicity testing to support improved stormwater discharge monitoring at this and many other outfalls on Navy installations.
Chris Stransky

Sewer Gas Elimination Technology (project no. 548)

The wastewater infrastructures at many Navy installations have been beset with sewer gas problems for decades without an effective remedy. Sewer gas often contains hydrogen sulfide (H_2S), methane, and other noxious gases. H_2S can cause corrosion of concrete sewers and pump station infrastructure, and can be lethal to humans at concentrations ranging from 100 to 500 parts per million.

This project plans to demonstrate ozone injection technology as a way to mitigate the generation and release of noxious and toxic gases in sanitary sewers.

H_2S is generated when sulfates are converted to sulfides by sulfate-reducing bacteria. Sulfates are universally present in stormwater and water rich in decaying matter, such as wastewater. Under the anaerobic conditions prevalent in sewer systems, sulfate-reducing bacteria, and therefore, H_2S, can thrive. The low-flow velocities found in many sewer systems allow the settling of organic matter, and this can cause anaerobic conditions and exacerbate the growth of this bacteria.

Additionally, the intermittent operation of pumps in pump stations results in the generation of high levels of H_2S gas. This gas may escape the system via manholes, drains, or malfunctioning sewer traps. This presents nuisance odor conditions, and health and safety risks, requiring increased expenditures for sewer infrastructure rehabilitation. Further, dissolved sulfides produced by bacterial reduction of sulfates present in the wastewater can exceed local dissolved sulfide discharge limits, triggering permit violations.

Ozone inhibits the growth of sulfate-reducing bacteria, and thereby limits the generation of associated noxious gases. Ozone can be safely and simply generated from ambient air, providing an effective option that is more sustainable than conventional sewer gas elimination strategies.

Team members, led by Steven Fann of NAVFAC EXWC, will demonstrate an ozone injection system at Naval Air Station Coronado. After a six month monitoring period to establish baseline conditions and quantify the extent of the problems, the team will dissolve ozone in water and apply it as a solution into the sewer. Gas levels will be monitored regularly, and the results of the demonstration will be compared with previous nitrate and ferrous salt injection demonstrations to develop a comprehensive method for the elimination or drastic reduction in emission of H_2S and other gases from sewers.

During project planning, the team will coordinate with the City of San Diego to gain acceptance of the technologies to be tested during this project. During the demonstration, the team will also invite interested parties from the Naval Facilities Engineering Command Southwest to the demonstration site for an overview off the technologies. The team also plans to work with end users via regional offices, and participate in Media Field Team meetings.

Demonstration of Optimized non-NMP (n-Methyl-2-pyrrolidone) Solvents for Immersion Chemical Depainting (project no. 549)

All of the products currently qualified per the MIL-PRF-83936 specification (Remover, Paint, Tank Type, for Aircraft Wheels, Landing Gear Components, and Other Aircraft) contain n-Methyl-2-pyrrolidone (NMP), which is classified as a reprotoxin, due to its detrimental effects on the reproductive system. NMP is a reportable constituent on the Toxic Release Inventory. It is also regulated as a chemical under the California Office of Environmental Health Hazard Assessment and as a European Chemicals Agency Substance of Very High Concern. An alternative non-NMP paint remover is needed.

Efforts are underway through the Defense Logistics Agency's Hazard Minimization and Green Products Program to revise the specification and to perform an initial demonstration of alternative, non-NMP materials to demonstrate acceptable performance. One product (D-Zolve 1533 IM), showed promise in early trials, but raised several concerns: the product evaporated rapidly, was easily removed from the component part, and emitted a strong odor. Through leveraged work with the Aircraft Equipment Reliability and Maintainability Improvement Program, the formulation is being optimized for the field application to correct these issues. The reformulated product will also enable the stripping bath temperature to be increased to improve stripping efficiency. Currently, the product is limited to operation at 120 to 125 degrees Fahrenheit because higher temperatures affect additional evaporative losses.

The oxygen and ozone generator.
Alex Mathews

If the reformulated product is suitable, this project, led by Joseph Santa Maria of FRC Southeast, will begin with a full demonstration/validation to validate its performance and ensure its compatibility with existing infrastructure.

Before the demonstration/validation can take place, the project team will perform coupon tests utilizing small squares or "coupons" of different substrates and various finish systems. The new formula will be compared to a control product that is currently qualified to MIL-PRF-83936. The product will be tested for paint removal performance, corrosion, strip rate, paint adhesion and hydrogen embrittlement. After the coupon testing, scale-up testing will take place at FRC Southeast to demonstrate and validate the new product for stability and maintainability, to establish process controls for quality improvement and to develop engineering documentation.

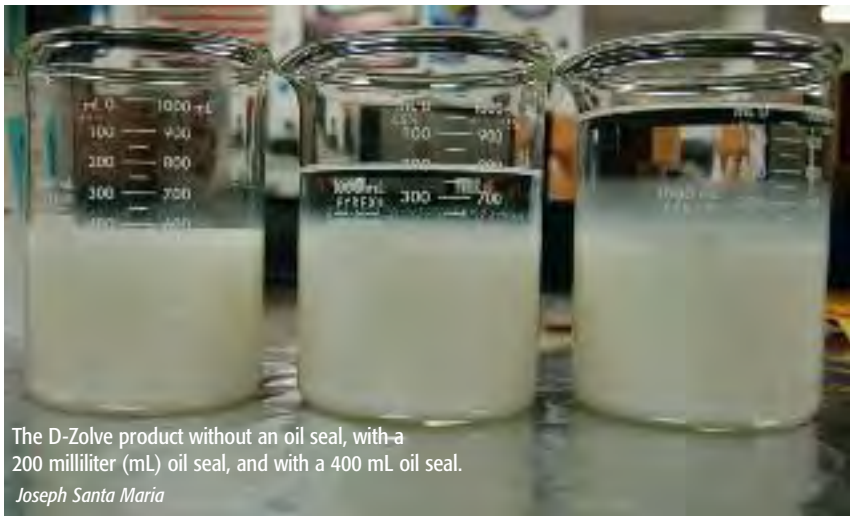
The non-NMP product will likely be a drop-in replacement for current products because the evaporation retardant will not likely affect the products' properties. In FY18, the plan is to revise the applicable technical manuals, Local Process Specifications, general series manuals, or and/or NAVAIR authorization letters in accordance with the new specification qualifications to prescribe the use of the new chemical at other facilities.

A Comprehensive Analysis and Strategy for Contaminated Sediment Management (project no. 550)

Contaminated sediment management is broadly estimated to be a one billion dollar problem for the Navy. The actual cost of managing these sites could be

even higher, since costs often grow as a site progresses from feasibility study to Record of Decision (ROD) to remedy design, to implementation. A systematic review of how and why these costs grow is needed.

This project was formed to prepare an Initiation Decision Report (IDR) to guide investments in the sediment remediation area.



The D-Zolve product without an oil seal, with a 200 milliliter (mL) oil seal, and with a 400 mL oil seal.
Joseph Santa Maria

At most remediation sites, the understanding and tools for determining the nature and extent of the contamination, the limitations of existing characterization tools and the shortcomings of current remediation and performance monitoring technologies are still evolving, as is understanding of regulatory/stakeholder expectations. Therefore, decision-making often occurs at every stage based on incomplete information.

The IDR will provide technical insights into and analysis of the sediment marketplace, identifying information gaps and limiting factors, such as Navy or regulatory policies. The report will indicate where sediment research, development, test and evaluation investments should be made to fill these gaps, and which technologies are ready for demonstration/validation today.

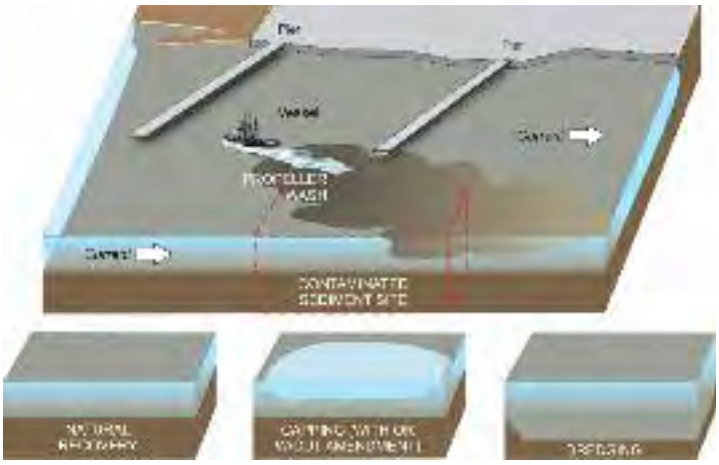
The project team, headed by Joey Trotsky of NAVFAC EXWC, will gather broad input from Remedial Project Managers in the Navy as well as non-Navy stakeholders (including the EPA, Army Corps of Engineers, individual states and others). Recent remedial investigations, feasibility studies, and RODs will be examined to identify end user-driven research needs for possible future NESDI investments.

The IDR will be disseminated through multiple technology mechanisms. Discussion of IDR results will also be presented to NAVFAC's Contaminated Sediment Workgroup and Alternative Restoration Technology Team. The report may also be incorporated into additional training seminars.

Impact of Sediment Resuspension by Propeller Wash and Shore Sediment Dynamics on Remediation Options (project no. 551)

While there has been significant progress toward both the identification and remediation of contaminated sediments at DoD harbors and waterways, there is a lack of understanding and public confidence on the effectiveness and permanence of these actions. Short-term remedial actions such as removal, and long-term actions such as capping and monitored natural recovery may be affected by site conditions such as propeller wash and wave action. This project, headed by Pei-fang Wang of SSC Pacific, was formed to provide more information regarding the effectiveness of various sediment remediation methodologies under real world stressors.

Dredging is one major contributor to the Navy's contaminated sediment management challenges.
MC1 Peter D. Lawlor



Propeller wash impact model. Processes include resuspension of contaminated sediment, near field mixing and re-deposition, far-field transport and re-deposition, and washing (with a portion of the sediment mass washed out of the harbor).

The Basics About the NESDI Program

THE NESDI PROGRAM is the Navy's environmental shoreside (6.4) Research, Development, Test and Evaluation program. The program is sponsored by the Chief of Naval Operations Energy and Environmental Readiness Division and managed by NAVFAC out of NAVFAC EXWC in Port Hueneme, California. The program is the Navy's complement to ESTCP which conducts demonstration and validation of technologies important to the tri-Services, EPA, and the Department of Energy.

For more information, visit the NESDI program web site at www.nesdi.navy.mil.

Sediment dynamics in harbors and shore regions are complex. The potential for resuspension of contaminated and remediated sediments, remigration of these suspended sediments to other areas, and recontamination of remediated areas by particles generated from other ongoing sources, complicate the performance of remedial actions. Under this project, a rigoros study will be conducted at Naval Base San Diego (NBSD) to examine the effect of sediment resuspension dynamics by propeller wash and shore sediment dynamics (wave action) on short- and long-term remedial options.

Issues covered will address how propeller wash may affect the stability and effectiveness of each remediation technique and how propeller wash and shore sediment dynamics may affect water quality and sediment recontamination.

Two protocols will be developed and demonstrated—one for the evaluation of the effect of resuspension events, the other for the evaluation of recontamination potential.

The protocols are based on data specific for the study site, for which numerical models have been previously validated. Existing estimates of daily tugboat activity at NBSD will be used to characterize and quantify resuspension by propeller wash. These data, in conjunction with baseline sediment chemical characteristics and calculations from the previously developed models, will help to determine the impact of propeller wash on each of the three sediment remediation options, including natural recovery, capping and dredging.

The knowledge and modeling tools to be developed will also be applied for intertidal shallow shoreline areas, where remediated sediment undergoes persistent and repetitive resuspension, migration and redeposition processes.

This project also leverages ongoing work sponsored by ESTCP and SERDP.

At the end of the project, the team will develop a report to help Navy Remedial Project Managers design and select remediation options for contaminated sediment sites where propeller wash and other factors may be an issue. ⚓

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NSWC Carderock Hosts Competition to Develop Wave Energy Converters

AquaHarmonics Wins the Energy Department's Wave Energy Prize

THE U.S. DEPARTMENT of Energy's (DOE) Office of Energy Efficiency and Renewable Energy announced AquaHarmonics as the winner of the 2016 Wave Energy Prize competition—which comes with a $1.5 million grand prize. The finalist teams tested their prototype devices at the nation's most advanced wave-making facility—the Maneuvering and Seakeeping (MASK) basin at the Naval Surface Warfare Center (NSWC) Carderock Division in West Bethesda, Maryland. CalWave Power Technologies and Waveswing America were awarded second and third place, respectively, with $500,000 and $250,000 in cash prizes.

A 20-month design-build-test competition, the Wave Energy Prize focuses on catalyzing the development of game-changing wave energy converters that will ultimately reduce the cost of wave energy. Wave energy is produced by converting the energy from waves into electricity.

With more than 50 percent of the U.S. population living within 50 miles of coastlines, there is vast potential to harness wave energy to provide clean, renewable electricity to communities, businesses, and cities across the United States.

Ninety-two teams registered for the prize beginning in April 2015. Over the course of the competition, a panel of judges ultimately identified nine finalists and two alternates, which were announced in March 2016. These teams received up to $125,000 in seed funding to build scaled prototypes of their wave energy converter devices.

On November 16, 2016, the nine finalists displayed their innovations at Carderock during the Wave Energy Prize Innovation Showcase. The event was attended by such distinguished guests as the DOE Under Secretary for Science and Energy, Dr. Franklin (Lynn) Orr; Assistant Secretary of the Navy (Energy, Installations & Environment), retired Vice Admiral Dennis McGinn, Deputy Assistant Secretary of the Navy for Energy, Joseph Bryan; and Founder, Chairman, and Chief Technical Officer of Masten Space Systems, David Masten.

The Wave Energy Prize focuses on catalyzing the development of game-changing wave energy converters that will ultimately reduce the cost of wave energy.

"The Wave Energy Prize marks a significant advance for marine energy," said Orr. "This competition set a difficult threshold of doubling the energy captured from ocean waves, and four teams surpassed that goal." The winning team's technology, in fact, actually quintupled the captured energy.

Alex Hagmuller and Max Levites-Ginsburg of team AquaHarmonics, both civilian engineers and graduates of Oregon State University, took the top prize with their wave

energy converter (WEC) concept and model of a point absorber with latching/de-clutching control. Levites-Ginsburg described their device as a buoy with a generator inside, anchored to the sea floor. Any relative motion from the point on the sea floor to the elevation of the device caused the generator to spin and produce electricity.

Alex Hagmuller, one of the co-winners of the 2016 Wave Energy Prize competition from AquaHarmonics, tells the crowd at NSWC Carderock how their WEC is working to absorb energy from waves, which can then be converted and used as a power source.
Monica McCoy

"Early on, we were working out of a garage and we didn't have a lot of resources or great facilities," Levites-Ginsburg said. "We tried to make the best of what we had, but we didn't really have a lot. It was really surprising what we were able to achieve." He added that they had been working on their project in some form for the last five years.

"The Wave Energy Prize laid out some goals for us to achieve that really pushed us in directions that maybe we wouldn't have pursued on our own," Levites-Ginsburg continued, "but ultimately led us down a path to enable us to make the right discoveries … and make the right design choices."

"AquaHarmonics' leap incentivized by the Energy Department demonstrates how rapid innovation can be achieved in a public prize challenge," Orr stated.

"It says so much about America, about America's innovation, [and] our inventors that this small team literally operating out of a garage in Portland, Oregon, [has] won this $1.5 million Wave Energy Prize," said McGinn. "For them, this is just the beginning. It's a wonderful milestone, and they will be moving forward to continue to refine and scale up this type of technology."

In the number two slot was CalWave Power Technologies, a team from Berkeley, California, who designed a submerged pressure differential device. Waveswing America, a company with 40 years of experience in wave energy research took third place with their sub-sea pressure-differential point-absorber.

A Long-term Cooperative Effort

The victory doesn't belong to the winning teams alone; it's also the culmination of years of work on the part of the many members of government and private industry involved in the Wave Energy Prize contest. Jim Ahlgrimm, director of DOE's Water Power Technologies Office, spoke at the beginning of the awards ceremony about DOE's vision for the contest and the critical support of Carderock and other partners in the contest. During the final phase of the competition, Carderock provided assistance in the form of signal conditioning, data acquisition, general logistics, mooring, and optical tracking. Carderock personnel also served as test directors.

Dave Newborn, an ocean engineer with Carderock's Maritime Systems Hydromechanics Branch, and Miguel Quintero, an ocean engineer with the Full-Scale Trials Branch, have been involved throughout the entire process. Their involvement included writing the competition rules, serving as judges and test directors, and providing technical and logistical support for contestants and program-identified partners like the Sandia National Laboratory in Albuquerque, New Mexico, and the National Renewable Energy Laboratory in Golden, Colorado.

Previous stages in the Wave Energy Prize involved competitors designing different archetypes for WEC devices, such as point absorbers, line absorbers and terminators. Then, contestants built and tested proto-

Aqua Harmonic's wave powered single point generator is demonstrated during an innovation showcase in the MASK basin at NSWC Carderock Division in West Bethesda, Maryland.

Petty Officer 2nd Class Heath Zeigler

The Basics About Carderock

NSWC CARDEROCK DIVISION, a part of the Naval Sea Systems Command, leads the Navy in hull, mechanical and electrical engineering. Headquartered in West Bethesda, Maryland, the Carderock Division employs approximately 2,000 scientists, engineers, technicians and support personnel and includes detachments in:

- Bangor, Washington
- Bayview, Idaho
- Fort Lauderdale, Florida
- Ketchikan, Alaska
- Memphis, Tennessee
- Norfolk, Virginia (Little Creek)
- Port Canaveral, Florida

types built to 1/50 scale. Subsequent to this stage, the original 68 competitors were narrowed to the nine finalists, who began conducting tests on 1/20-scale prototypes in the MASK basin.

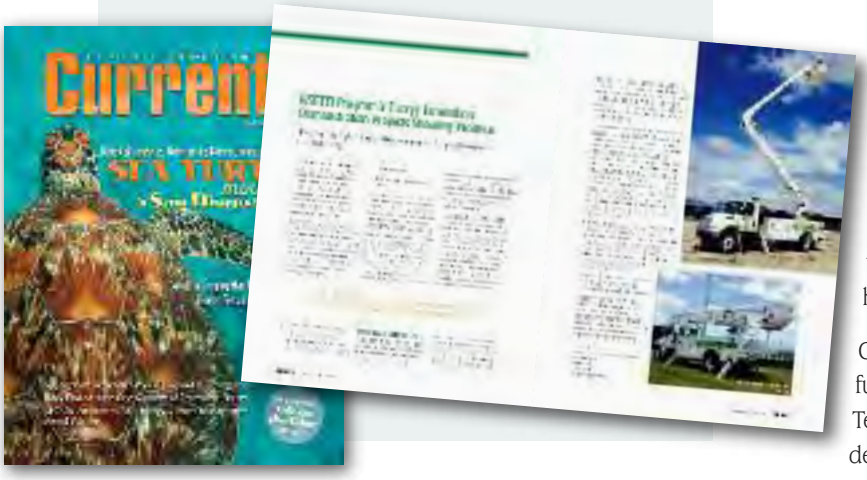
"The reason the testing has moved here at this stage is that no one has a facility this large that can generate waves of this size to get the appropriate scale for the devices," Newborn said. "The DOE came to us because of the big tank, the big waves we can make, and the expertise we have here. There's a lot of money at stake here. With a vital program like this one, the data has to be as thorough and accurate as possible."

The Wave Pool

The MASK basin, where the final competition took place, is the Navy's largest wave pool. It's 360-foot long, 240-foot wide, and holds approximately 12 million gallons of water. It's used to evaluate the maneuverability, stability and control of ships, platforms and moored systems in realistic sea conditions.

For More Info

FOR MORE INFORMATION about the work taking place at this facility, see our article in the winter 2015-16 issue of *Currents*, "NSETTI Program's Energy Innovation Demonstration Projects Showing Promise," by visiting http://greenfleet.dodlive.mil/files/2016/02/Win15-16_NSETTI_Energy_Demo.pdf.



Built in 1962, the basin recently underwent a six-year upgrade to replace the original pneumatic wave making system with 216 individually controlled electromechanical wave boards that significantly enhance the capability to create a precise wave environment and simulate the ocean's most extreme conditions.

Hosting the competition at the basin provided additional benefits to the command. An underwater optical tracking system, developed for use in the tests, provides the ability to track motions for submerged or surface-piercing bodies. This system is being tuned and modified for use at Carderock, with the goal of establishing a flexible, reconfigurable motion-capture system that could track bodies in the entire basin and sections of the other basins around base.

The MASK basin isn't the only Department of Navy facility involved in developing and testing WEC technologies. The Wave Energy Test Site, in the waters off Marine Corps Base Hawaii, has been working in the field since 2003. Two additional testing berths were installed in 2014 as interest in the environmental feasibility of wave energy generation begins to build.

The goal of the Wave Energy Prize is to determine which archetype device is best to move forward with. "It's about what it costs to get the power; not just getting renewable energy, but doing it at a cost that makes sense," Newborn said.

"If you look around, it doesn't take long to go to the beach and see, 'Wow, that's a lot of energy,'" said McGinn. "So figuring out how we can harvest that energy in an inexpensive, reliable way makes so much sense. It will add to our energy portfolio...along with wind and solar."

The wave energy sector is in its early stages of development, and the diversity of technologies makes it difficult to evaluate the most technically and economically viable solutions. The Wave Energy Prize competition addressed this challenge by comparing a wide range of device types and evaluating them against a threshold requirement for high energy capture.

Go to water.energy.gov for information on funding opportunities through the Water Power Technologies Office. This office sponsors the development of innovative technologies that generate renewable, environmentally friendly, and cost-competitive electricity from water resources.

To see the full results of the competition or for more information about the Wave Energy Prize, go to waveenergyprize.org. ⚓

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NSWC Carderock Answers the Call to Protect Marine Life

Surface Warfare Center Commissions New Ballast Water Research Laboratory

THE NAVY COMMISSIONED a new Ballast Water Research Laboratory at the Naval Surface Warfare Center, Carderock Division to address and study the transport of aquatic nuisance species associated with ballast water.

Traveling across the globe from port to port, the U.S. Navy fleet transports Sailors and Marines, aircraft and supplies. Unfortunately, ships can also unintentionally transport stowaways, small organisms that are pulled into ballast water. Most people would not look at small organisms like mitten crabs or zebra mussels and think they are a major threat to the environment—and in their natural habitats they pose no threat. But what happens when these organisms are introduced into a new ecosystem?

According to Rachel Jacobs, a chemical engineer in the Wastewater Management Branch at the Naval Surface Warfare Center, Carderock Division, the results of introducing non-native species into a new environment can be disastrous for the ecosystem, for industry and for the marine life that already inhabit that environment. These small creatures, as well as many other organisms, can be transported through a vessel's intake and release of ballast water from one body of water to another.

Ballast water is taken in by a ship to maintain its position in the water using sea valves or pumps. The ship's stability depends on ballast water being taken in or discharged when cargo is loaded or unloaded, when the ship is traveling into different depths of water, or to adjust trim or list.

From an environmental standpoint, the problem with ballast water is that it is a means to transport aquatic nuisance species. To address and study this issue, Carderock commissioned a brand-new Ballast Water Research Laboratory on December 5, 2016 at its headquarters in West Bethesda, Maryland.

Through the use of the new laboratory, engineers and scientists at Carderock will be able to study ways to treat ballast water so that by the time ballast water is discharged at a ship's final destination, those organisms that lurk in the water will not be released to live and damage the ecosystem. The new laboratory gives researchers the capability to replicate the salinity and sediment profile of any body of water in the world. Jacobs is also looking forward to the addition of the nursery, which will give researchers the ability to grow and culture their own organisms.

"The issue of introducing non-indigenous species via ballast water has come more to the forefront internationally these days due to the

The problem with ballast water is that it is a means to transport aquatic nuisance species.

Naval Surface Warfare Center, Carderock Division Commanding Officer Capt. Mark Vandroff (right) and Technical Director Dr. Tim Arcano officially open the Ballast Water Research Laboratory on December 5, 2016 in West Bethesda, Maryland.

Monica McCoy

incredible environmental and economic repercussions that have occurred," Jacobs said. "Ships can transport a lot of organisms in ballast water because what you're doing is bringing in thousands—sometimes millions—of gallons of ballast water onto a ship, and you're delivering them to a new locale when you go to your next port of call.

"It's the sort of situation where you had power plants being horrendously impacted by zebra mussels; you had total biological ecosystems being devastated in California with mitten crabs; and in the Chesapeake Bay we've had the rapa whelk attacking oysters, which are one of the big economic drivers for Maryland and the watermen."

Jacobs, a graduate of the University of Maryland with degrees in chemical engineering and marine biology and a master's degree in environmental engineering from Johns Hopkins University, is a member of the team that facilitated the designing of the Ballast Water Research Laboratory. She and Toby Cole, a chemical engineer who was a team member and is now the deputy division head of Carderock's Environment and Energy Division, were the principal investigators for the project laboratory under the auspices of branch head Stephan Verosto, also a researcher on Navy ballast tank designs.

"There's been an incredible global push for years to reduce the introductions of aquatic nuisance species that has been headed up by the International Maritime Organization; and that's how parameters were developed for ballast water treatment," Jacobs said.

The Ballast Water Research Laboratory's setup spans two levels. Water is pumped from the salt-control tank and the sediment-control tanks on the ground floor to the mix tank on the mezzanine level. Eventually, the nursery tanks will be housed on the mezzanine level where organisms can be added in the mix tank and then fed into systems under evaluation. Engineers and scientists can then test the status of the organisms and other parameters in a sample tank on the ground floor.

"We are working with the [Carderock] Naval Architecture and Engineering Department using virtual computational fluid dynamics to actually see how water flows within specific ballast tanks in specific ship classes. We will be able to take that and then turn that into physical scaled models and test those models in the laboratory," Jacobs said.

Carderock Director of Research Dr. Jack Price committed the funds for the laboratory—which was four years in the making—after a proposal modeled from a concept Jacobs and the wastewater management team

were able to come up with in just over 24 hours. "The need and enthusiasm for such a laboratory was evident," Price said.

"There was a lot of research that was involved in doing the computational fluid dynamics calculations by our hydrodynamics people," Price said. "There's also all the parts that the wastewater management folks were bringing to bear in the knowledge of the types of species you're going to want to deal with, what their densities are, sizes and weights, etc. So it's a complicated problem, and I think we built a unique laboratory to appropriately simulate that.

Capt. Mark Vandroff (left) and Dr. Tim Arcano pour Potomac River water into a tank as part of the grand opening of Carderock's new Ballast Water Research Laboratory.
Monica McCoy

"With the fact the laboratory consists of lightweight Nalgene, or plastic tanks, you can set the laboratory up in new configurations if you have to so you can simulate the different configurations you might encounter in different ship classes. That makes it an easy module-type approach so that we can do good, accurate testing."

The Carderock Commanding Officer Capt. Mark Vandroff and Technical Director Dr. Tim Arcano commissioned the Ballast Water Research Laboratory in a ribbon-cutting ceremony by pouring water from the Chesapeake Bay into one of tanks.

"I am extremely proud to have a Ballast Water Research Laboratory here at Carderock because this is good for the environment," Vandroff said. "With our ships going all over the world, we have to be able to comply with such environmental demands or we're not going to have the access we need to fulfill our mission. The addition of this laboratory is really going to enhance our fleet."

According to Rita Schuh, the Ballast Water Management Technical Area Leader and environmental engineer in the Wastewater Management Branch, the new Ballast Water Research Laboratory will provide tools necessary to continue to study and innovate ways of treating ballast water and meeting various regulations.

"Unlike major commercial transport ships that have dedicated transit lanes, the U.S. Navy goes all over the ocean,"

The Basics About Carderock

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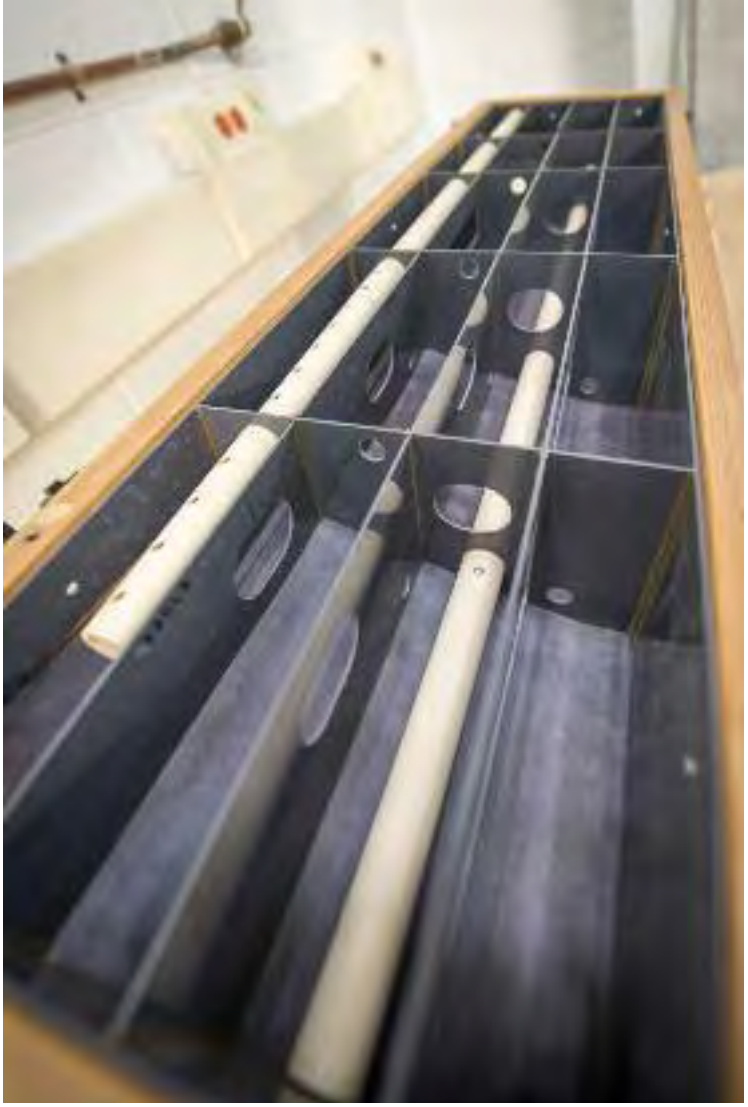

An Arleigh Burke compensated ballast tank model (5-300) on display at Carderock's newly-commissioned Ballast Water Research Laboratory.
Monica McCoy

Schuh said. "Navy vessels are not always going to be in the same kind of water in the same part of the world and are not held to the same limitations. So we need to be able to ballast everywhere—in all conditions, all salinities and all temperatures. It is important to find a really robust treatment of ballast water that doesn't limit our operations."

According to Jacobs and Schuh, different treatment options have been tested in the past, but the goal is to come up with a way to ensure that no live organisms are being dumped into bodies of water to interfere with the ecosystem of native species.

"Ultraviolet radiation (UV) is one set of treatment technology that has been tested, although there have been issues in terms of how effective it is at killing the organisms versus deactivating. The whole point of UV is to basically inactivate the DNA in the organism so it's unable to replicate. It's not an official kill as compared to an inactivation, but then we have to figure out how to test for that," Jacobs said. "There are other treatment technologies in terms of chlorine dioxide and deoxygenation and all sorts of different things that have the potentiality for use."

An underside view of the Ballast Water Research Laboratory's upper test platform.
Monica McCoy

Schuh and Jacobs said they are glad to have a facility like the Ballast Water Research Laboratory that provides them the versatility to do proper testing of ballast water solutions, and they are enthusiastic about the opportunity to do their part to help protect the environment by solving the problems associated with the transport of ballast water.

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Indian Island Provides Critical Habitat for Bald Eagle

Tracking & Rehabilitation Centers Help to Protect American Icon

EFFECTIVE TRACKING AND rehabilitation facilitated by personnel from Naval Magazine (NAVMAG) Indian Island are helping to preserve critical conservation habitat for the island's bald eagle population.

The majestic bald eagle was almost lost to America due to deforestation and the caustic chemical legacy of DDT. Now the eagle has made a comeback for the ages. From a low in 1963 of 400 nesting pairs in the lower 48 states, to nearly 10,000 nesting pairs today, the recovery and delisting of the nation's iconic symbol marks a major achievement in conservation. This is due in no small part to the conservation efforts of America's military.

The Navy's efforts to maintain low density development on its installations in the Pacific Northwest has resulted in the doubling of the nesting eagle population on NAVMAG Indian Island since 1994. Today, the island provides 2,700 acres of critical conservation habitat for 10 nesting eagle pairs.

The Navy's primary mission on NAVMAG Indian Island is to provide conventional ordnance support to U.S. Navy and U.S. Coast Guard ships stationed in the Puget Sound and to all west-coast aircraft carriers. Because of this critical national defense mission, there is no active development on the island.

While the nation's military provides protection for America and her allies, the Department of Defense (DoD) maintains a strong conservation effort at all its locations. So much so that creatures of all kinds congregate on the vast holdings of military installations. In fact, the DoD manages and protects 400 threatened and endangered species on 25 million acres of land across 420 military installations. The Defense Department now manages more species per acre than any other federal agency, including the National Park Service, U.S. Forest Service and U.S. Fish and Wildlife Service (USFWS).

This suits the Indian Island bald eagle population just fine, as the birds need room to roam and raise their young. The bald eagle is highly territorial and needs plenty of room to spread their wings and build their nests. An eagle's nest can weigh up to 4,000 pounds, requiring a massive tree to support the weight. The eagle pairs select a sizable tree near the waterline, so they may fish and keep an eye on their nest at the same time. While the mature eagle has no natural enemies, fledgling eagles are a tasty treat to other birds like hawks, crows and ravens.

The USFWS in conjunction with Indian Island environmental site manager Bill Kalina, have tagged the

The Navy's efforts to maintain low density development on its installations in the Pacific Northwest has resulted in the doubling of the nesting eagle population on Naval Magazine Indian Island since 1994.

Indian Island bald eagle in flight.

island's eagles with satellite transmitters. As a result, USFWS can track an eagle's whereabouts. These transmitters allow biologists to track the seasonal distribution of the eagle pairs when they depart the nesting area. Typically, Indian Island eagles travel to the nearby Skagit or Fraser Rivers during salmon spawning, to feed.

Additionally, by tracking the eagles, biologists can determine the eagle's home range. The accumulated data is then used to monitor species health and to protect their habitat areas from further encroachment.

In order to tag an eagle, one must first capture an eagle, which is no small task.

Using herring as the bait, USFWS biologists will float the fish out in the bay. Normally, seagulls will first attack the bait, followed by the eagle chasing the seagulls away. When the eagle goes after the bait, the bird gets tangled up in the trap.

At this point, USFWS personnel will toss a big blanket over the eagle to subdue it and bring the bird into the boat for tagging. The eagle is released with a small satellite transmitter attached which allows the Service to keep track of the bird.

"People may think we name the eagles we monitor, but that's not true," Kalina stressed. Instead, the eagle's nest is named after the place it is located. For example, there is the "North Beach pair," and the "Boggy Spit pair," and so on.

But now there is a real estate shortage for nesting eagles on Indian Island. The highly territorial bird doesn't want other eagles roaming the neighborhood and will fight those that try to set up housekeeping next door. As a result of these neighborhood brawls, the losing eagle ends up a little woozy, injured and at times unable to fly. Indian Island security personnel who come across an injured eagle, notify the environmental site manager, who then contacts the wildlife rehabilitation centers in the nearby towns of Sequim or Bainbridge Island. These rehabilitation centers are privately owned non-governmental facilities. These non-profit facilities run on public donations.

Wildlife rehabilitation center personnel attempt to nurse injured eagles and other animals back to health. The primary goal is to return the injured back to the wild, if at all possible. If the animal cannot go back to the wild, they may be used for educational purposes at local schools and businesses.

Eagles can live as long as 50 years and mate for life. The eaglets are born in spring and are learning to fly from tree to tree by summer. By fall, they are on their own. In five years, the plumage on the neck and head turns white and, at six years old, the eagle is ready to find a mate and build its own nest. The bald eagle takes seriously the term "until death do us part." When an eagle's mate dies, the "widow" goes salmon fishing, looking for a new mate. When the "widow" finds a new mate, they take up residence in the old nest.

The Navy's efforts to maintain low density development on its installations in the Pacific Northwest has resulted in the doubling of the nesting eagle population on NAVMAG Indian Island since 1994. An eagle's nest can weigh up to 4,000 pounds, requiring a massive tree to support the weight.

For More Info

FOR MORE INFORMATION about Navy Region Northwest, please call 360-396-1630, or visit: www.homeportnorthwest.wordpress.com, www.cnic.navy.mil/regions/cnrnw.html, and/or www.facebook.com/CNRNW.

The bald eagle first gained federal protection in 1940, under what later became the Bald and Golden Eagle Protection Act. The nation's eagle population fell into steep decline due primarily to widespread use of the pesticide DDT after World War II. DDT accumulated in eagles and caused them to lay eggs with weakened shells, decimating the eagle population in the lower 48 states. Concerns about the bald eagle resulted in its protection in 1967 under the predecessor to the current Endangered Species Act (ESA). The eagle was one of the original species protected by the ESA when it was enacted in 1973.

Fortunately, the bald eagle never needed the protection of the ESA in Alaska, where the population is estimated at between 50,000 and 70,000 birds. The bald eagle was delisted from the Federal List of Endangered and Threatened Wildlife and Plants in 2007. ⚓

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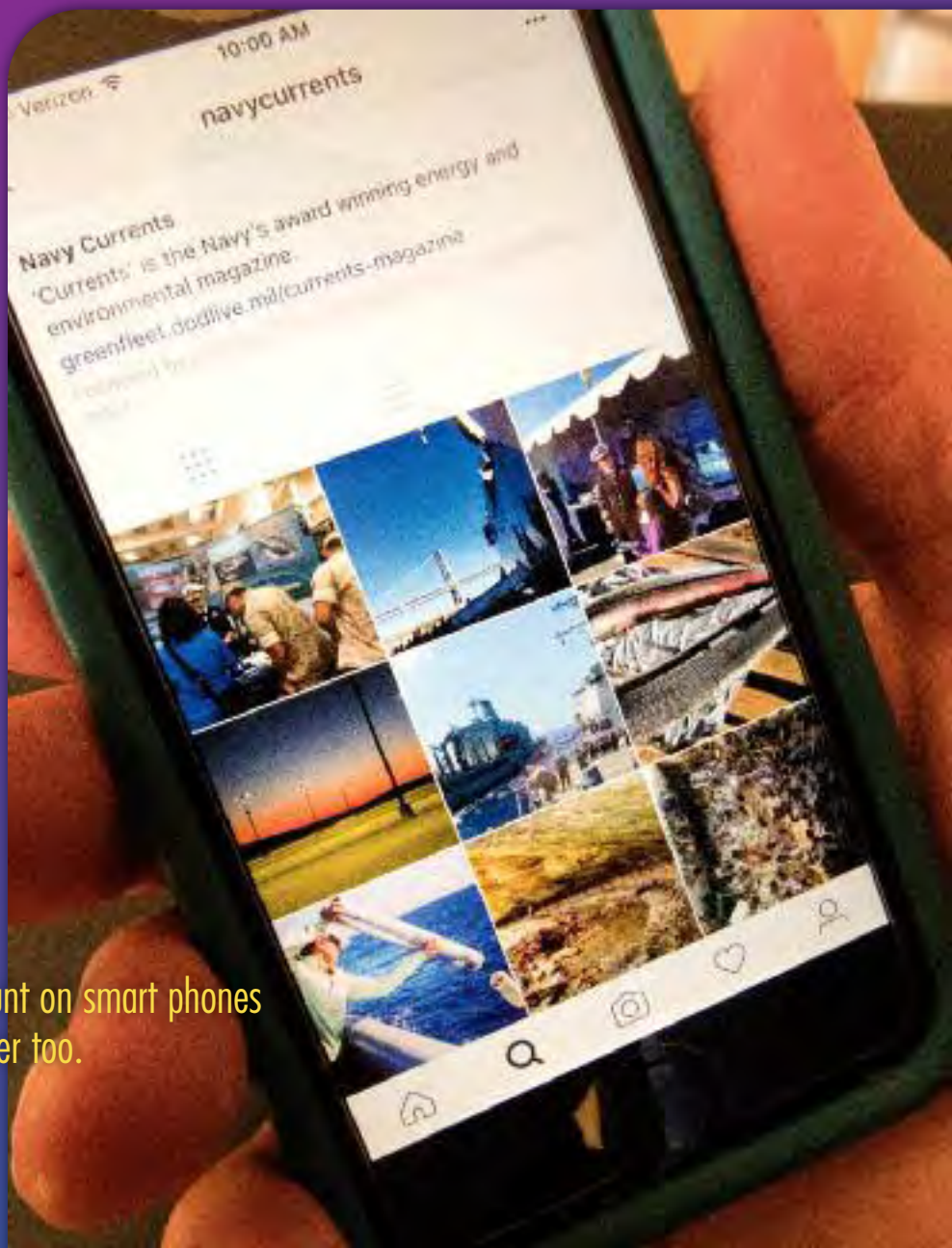

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